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AMERICAN TELEPHONE PATENTS.

IN the leading columns of one of our recent issues we expressed our doubt whether the persons who obtained permission to use the name of the United States in proceeding against the Bell patents would, after that permission had been rescinded on account of irregularity, again attempt to achieve their desire by compliance with the customary observances. They have done so, however, and have been joined by other antagonists of Bell, notably, the Globe Telephone Company, which supports the claims of Meucci, in petitioning the Government to take action to vacate the Bell patents upon the grounds already made public. The Secretary of the Interior, two assistant secretaries, and the Commissioner of Patents are investigating the matter, and have already heard the petitions of several parties. Our readers will remember that fraud is the main point relied upon, it being alleged that Bell or his attorneys saw Gray's caveat after the former had filed his specification, which he afterwards amended. It is also, however, alleged that Bell could not truthfully claim priority of invention, because Reis, Meucci, Gray, and others had made and used telephones before he made his application. It is within the power of the officers who are sitting to hear only an *ex parte* statement, and to proceed thereupon; but they have acceded to the representation of the Bell Company, whose counsel have, according to the New York papers, taken part in the proceedings.

The object of the petitioners in desiring to obtain the assistance of the United States will, perhaps, be more clearly perceived from the explanation of Mr. Casey Young, the attorney for the combined opposition. He says:—"There is but one object in endeavouring to secure the use of the name of the United States in a suit to cancel the patent, and that is to make the case a United States case, so that when it reaches the United States Supreme Court on appeal, it will, under the rules, secure an advanced position in the docket, and be certain of a hearing. That will enable us to get a decision within a year or two; whereas, as complainants or defendants in a suit in a court without the aid of the Government, the Bell Company could easily interpose so many objections that there might be delay until the Bell patent had expired. To prevent this delay is practically the only object which we seek in endeavouring to obtain permission to use the name of the United States."

It seems from the American papers that the argument in the present proceedings will be taken, not upon the application of the Globe or Pan Electric Company, but upon the petition of certain citizens of Memphis, which sets forth, substantially, what was alleged by the companies, that the Bell patent was obtained by fraud, and was illegally granted.

The most interesting point of the proceedings so far, has been the production of the "fee slip" attached to Gray's caveat, which contains a memorandum that the fee for the caveat was paid on February 14th, 1876, the day on which Bell's application was filed, but that the caveat itself was withheld, there being a custom allowing applicants till ten o'clock on the day following the payment of the fee to file their papers, which are, however, dated on the day on which the fee is paid. If there is shown to be anything in this evidence, there can, of course, be no question as to Bell's priority as far as Gray is concerned; but we await further developments of the case before forming any opinion thereon.

When the Interior Department will make its report is quite a matter of conjecture, the time which it will take to carry out the programme it has decided to follow being variously estimated at a day or two and a month. It certainly is to be hoped, however, that the petitioners will have their prayer granted, for, while the Bell Company can be in no way placed at a disadvantage through having the United States pitted against it, this course seems the only one which will secure a full and fair investigation of every piece of evidence on either side.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

IV.

VARIOUS modifications of Prony brakes have been introduced from time to time, but such modifications are merely in the details of construction. Fig. 2 represents one of the Author's design; the pulley is provided with adjustable jaws of steel, tightened up by means of screws in a manner similar to the chuck of a lathe; an American chuck with three jaws, moving simultaneously, would be still better, as it allows of a speedy and accurate adjustment to various sized spindles, thereby removing the necessity of keeping as many pullies as there are spindles of different diameters. In this brake, the upper half of the pulley only carries a wood block, and the lower part has a steel band which is pressed against the pulley face by means of levers hinged upon the wood block; the levers are worked through two nuts and a right and left handed screw, fixed upon the central hand wheel. The pressure can by this means be adjusted with greater regularity than in the case of plain bolts and ordinary tightening nuts. For the purposes of lubrication, the lower part of the pulley with the steel band may dip into a trough containing soapy water. The lever is balanced by a counterweight, and it is bent downwards to increase the stability.

In order to render the coefficient of friction, or the pressure between the friction surfaces, automatic, within certain limits, several ingenious devices have been invented; amongst these is one by the late Professor Fleeming Jenkin, another by M. Raffard, one by Professors Ayrton and Perry, and others. Professor Jenkin's brake is shown by figs. 3 and 4; it consists of two pullies of equal diameters; the pulley, M, is loose upon the motor shaft, S, and pulley, T, is fixed to the shaft by means of a key, or an adjustable clutch. Pulley M, carries two cords, P and *p*, preferably of leather; cord *p*, is held by an eye, F, in the middle of the rim, and cord, P, is supported by a bracket, D,

which is fastened to M. When D stands vertical with reference to the centre line of the spindle, then each cord embraces about a quarter of the circumference of its own pulley. The requisite friction between the cord, p, and its pulley, T, is obtained by suspending weights, P and p, on the free ends. On setting the motor in motion (in the direction of the arrow), the cord and weight, p, will be pulled downwards, by the adhesion of the cord, and the bracket, D, will swing round towards a new position, y, or beyond it, the frictional surface being thereby diminished; now, in order to bring D to its vertical position, either p has to be diminished or P increased; whether a diminution or increase in the weight has to take place depends upon the speed at which we desire to run the motor. Supposing the weight, P, is too great, then D will be pulled over towards or beyond the point x, and the arc embraced by the cord, p, will be augmented. It will be seen that the frictional surface adjusts itself to a certain extent, and we have merely to add or remove weights in order to establish equilibrium. If the speed is too great when D is in its normal position, then we have to add weights to both P and p, and, of course, proportionately more at P, as the friction between the points D and q must increase faster than the sum of the added equal weights. To calculate the H.P. absorbed by the friction of the cord, the following formula applies:

$$\text{H.P.} = \frac{d \times 3{\cdot}1416 \times (\text{P} - p)}{33000}$$

where d is the distance between the cords measured in a line at right angles to the spindle; P and p are the weights in pounds.

If the weights and dimensions are on the metric system, then the divisor will be as given in Article III. for the Prony brake. For the testing of motors of not more than 3 H.P., this is the handiest dynamometer one could wish for. With the exception of the bush in M, which has to stand still, whilst the shaft, s, revolves, there is no lubrication required, if the experiment is of a short duration. In the case of extended tests, a small stream of water will keep the pulley tolerably cool. The leather cord deteriorates in a comparatively short time—it wears away; but this is a small matter.

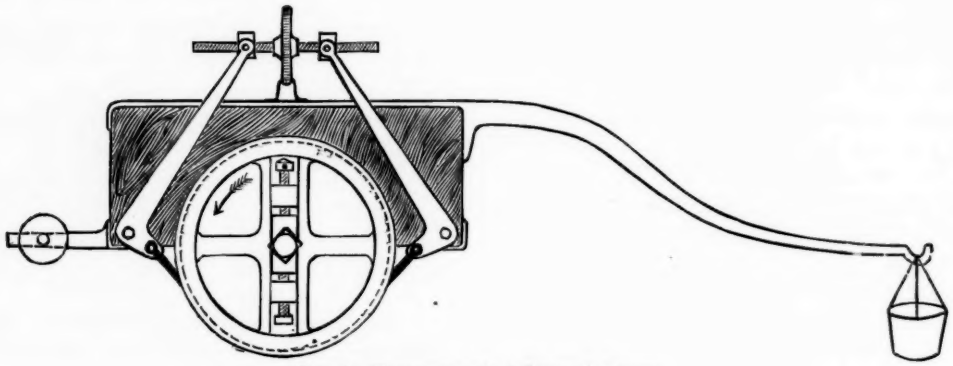


FIG. 2.—RECKENZAUN'S "PRONY" BRAKE.

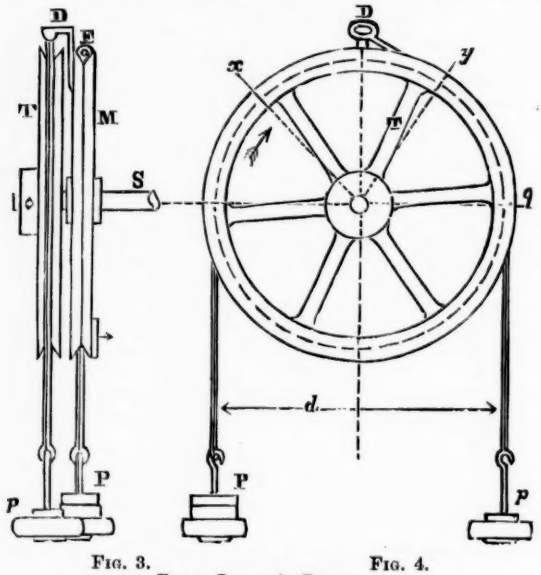


FIG. 3.

FIG. 4.

PROF. JENKIN'S BRAKE.

The balance weight shown by arrow head = the weight of D.

ON SOME PRACTICAL ELECTRICAL FORMULÆ.

(For use in Constructing Circuits, Electro-magnet Coils and Dynamos.)

By F. V. ANDERSEN.

PART II.—*(Continued from page 431.)*

On an Electrical Figure of Merit of Dynamos.

C.—*The Merit of a Dynamo with Electro-magnets for Field.*—For the dynamo in which the field is formed by electro-magnets, we have, as for the magneto machine, activity

$$\text{W} = \text{F V L } s\, a \text{ watts}$$

and electrical efficiency, when

$w\,a$ = rate of waste in armature in watts
$w\,m$ = „ in field „ „

$$\eta = \frac{\text{work in external circuit}}{\text{activity}}$$

$$= \frac{\text{W} - (w\,a + w\,m)}{\text{W}}$$

$$= 1 - \frac{w\,a + w\,m}{\text{W}} \qquad \text{VII.}$$

so that $100\ \frac{w\,a + w\,m}{\text{W}}$ is the percentage of work wasted in the machine.

Since $\text{W} = \text{F V L } s\, a$, it might seem as if that percentage was also in this machine inversely proportional to F; but remembering that F will rise by using more energy for exciting the field, *i.e.*, by increasing the percentage of waste, we see that F cannot express the merit of a dynamo of this class. We might use so much exciting power on the field, that F would rise to a maximum, while at the same time the percentage of energy wasted became 50 per cent. of the total amount

converted. Although a machine in which this was the case would have a very high figure for F, its merit would necessarily be very low.

The percentage of waste is by the magneto machine $100\,\frac{w\,a}{\mathrm{W}}$, by the electro-magnet machine $100\,\frac{w\,a + w\,m}{\mathrm{W}}$.

In looking from the former to the latter we find an increase in the percentage of waste at the rate of

$$\frac{w\,a + w\,m}{w\,a}$$

I shall show that if, as suggested above, the merit of the magneto machine is expressed by F, then the merit of the electro-magnet machine can be taken as F divided by this increase in the proportionate waste, *i.e.*,

$$\text{Merit of el. mg. machine} = \frac{\mathrm{F}}{\frac{w\,a + w\,m}{w\,a}}$$

$$= \mathrm{F} \times \frac{w\,a}{w\,a + w\,m},$$

$\frac{w\,a}{w\,a + w\,m}$ being the proportion of the total waste which falls on the armature.

Suppose we have two fields, one made of steel-magnets without electrical excitement, the other composed of electro-magnets, and to fit these two fields we have one armature, which is used alternately in one or other of the two. In both cases we spin the armature at the same velocity and take out current of the same intensity. Let the electro-magnetic-field be excited by the armature to such a degree that the density of this field is exactly equal to that of the magneto-field.

We shall then have W equal for the two cases, but in exchanging the magneto for the electro-magnet-field, we get an increase in the percentage of waste at the rate of $\frac{w\,a + w\,m}{w\,a}$, while at the same time more copper conductors have been taken in use to produce the work, namely, the conductors forming the exciting coils on the electro-magnetic-field, the increase in the volume of copper used to produce the same work being at the rate of

$$\frac{\mathrm{L}\,s + \lambda\,\sigma}{\mathrm{L}\,s}$$

λ and σ meaning the length and cross-section respectively of the conductor forming the field-magnet coils.

Now, from formula IV.

$$(\mathrm{W} = \mathrm{F}\,\mathrm{V}\,\mathrm{L}\,s\,a)$$

and VI.

$$\left(\eta = \mathrm{I} - \frac{a\,\kappa}{\mathrm{F}\,\mathrm{V}}\right)$$

we can define the proposed figure of merit of the magneto-dynamo (F) as the figure to which, by constant amount of work done in unit time, the volume of conductor and the percentage of waste are inversely proportional (V and a being standards).

EXAMPLE.—Let the magneto-dynamo be altered mechanically so as to receive an alteration in its F—for instance, by the steel-magnet poles being drawn farther away from or moved closer up to the armature-body—and call the new constant $p \times \mathrm{F}$ (p may be greater or smaller than I), then to produce the original power—F V L s a—at the same velocity and rate of current, we must alter the volume of copper to $\frac{\mathrm{L}\,s}{p}$ and this involves that the percentage of waste, which was originally

$$\frac{s\,a^2\,\kappa\,\mathrm{L}}{\mathrm{F}\,\mathrm{V}\,\mathrm{L}\,s\,a} = \frac{a\,\kappa}{\mathrm{F}\,\mathrm{V}} \qquad \text{(VI.)}$$

becomes

$$\frac{a^2\,\kappa\,\frac{\mathrm{L}\,s}{p}}{p\,\mathrm{F}\,\mathrm{V}\,\frac{\mathrm{L}\,s}{p}\,a} = \frac{a\,\kappa}{p\,\mathrm{F}\,\mathrm{V}}$$

If, therefore, F is the merit of our dynamo when used with the magnet-field, then

$$\mathrm{F} \times \frac{w\,a}{w\,a + w\,m}$$

is the merit of it when working with the electro-magnet field; for $\frac{w\,a}{w\,a + w\,m}$ is the rate of alteration in the percentage of waste (corresponding to p in the example).

The coefficient $\frac{w\,a}{w\,a + w\,m}$ should now be equal to the value of $\frac{\mathrm{L}\,s}{\mathrm{L}\,s + \lambda\,\sigma}$ which is the inverted proportion of the amounts of copper conductors required to give the same power in the two cases.

That $\frac{w\,a}{w\,a + w\,m} = \frac{\mathrm{L}\,s}{\mathrm{L}\,s + \lambda\,\sigma}$

requires

$$w\,a \times \mathrm{L}\,s + w\,a \times \lambda\,\sigma = w\,a \times \mathrm{L}\,s + w\,m \times \mathrm{L}\,s$$

or

$$\frac{w\,a}{w\,m} = \frac{\mathrm{L}\,s}{\lambda\,\sigma}$$

which means that energy is absorbed at the same rate in the field as in the armature coils. Now this is in practice not the case; the absorption of energy in a conductor is proportional to the square of a (the ampères per square inch); and in field coils a is generally about half, or somewhat less than half, so great as in armature coils. It would, therefore, seem that a reduction of F by $\frac{w\,a}{w\,a + w\,m}$, which is the correct value in regard to the proportionate waste, would be insufficient in regard to the volumes of copper. The copper conductors should, however, not count against the merit in proportion to their volume, but in proportion to their commercial value as parts of electrical apparatus; and it will, from this point of view, be admitted that the conductors of armatures, by which the labour of preparing, winding, and connecting, amounts to more than the expense for copper, and which have a more limited life than those of the field, must count heavier against the merit than these. On this ground, I think that it will be just to count the copper of the field coils against that of the armature coils, in proportion to the energy absorbed in each class respectively. We then get for the electro-magnet machine:

$$\text{El. merit} = \mathrm{F} \times \frac{w\,a}{w\,a + w\,m} \qquad \text{VIII.}$$

while for the magneto machine:

$$\text{El. merit} = \mathrm{F}.$$

In the following table I give the results of my tests of three (in regard to their electrical merit) very different dynamos.

An examination and comparison of the various figures is interesting.

No. 2 is a machine in which too much energy is used for exciting the field; the proportion of total activity used for this purpose being ·14. This shows itself by a distinct fall in the merit and efficiency comparing this machine with No. 1; while F of No. 2 is practically equal to F of No. 1.

No. 3 stands out very much from the two others in all respects. Although its field absorbs only 3·7 per cent. of its total work, its F is over 70 per cent. higher than in No. 1 and 2. As a consequence of this, it needs only little copper on the armature; and the fact that this is taken of small wires and distributed in a thin layer on the core, allows the rate of current to be, without undue heating, 50 per cent. higher than in the other machines. Its electrical efficiency is even when working at this enormous rate still higher than that of the former machines. It would, evidently, be wrong to compare such a machine electrically to No. 1 by the figures of their electrical efficiencies

(working each at its normal rate), 87 and 85 per cent. respectively. The figure of merit which I propose expresses, I think, better the proportionate values of the two machines.

If we let No. 3 machine work at the rate of 2,760 ampères per square inch, like No. 2, its percentage waste in the armature, which is proportional to a, becomes $6\frac{1}{4}$ per cent., and η will then be over 90. My figure of merit has the advantage of allowing for the stronger rate. To have this figure correct, all we need is to let each machine work at a maximum safe working temperature, and then take our measurements of velocity and electrical quantity and potential.

I remark that the three machines compared in the table are all shunt machines, working at approximately same potential. The main difference in their construction is that No. 3 has a much heavier and better constructed iron field than the others, and the pole-pieces are considerably closer to the iron body of the armature than in those. I have tested machines which hold a high reputation for efficiency, but which are far inferior to No. 2.

No. of Machine.	L Feet.	s Sq. ins.	a	V Feet per sec.	W ($F\ V\ L\ s\ a$) in Watts.	Watts External.	$w\ a$ in Watts.	$w\ m$ in Watts.	$\frac{w\ a}{W}$	$\frac{w\ m}{W}$	F	Merit. $F\frac{w\ a}{w\ a + w\ m}$	Per Cent. η
1	1260	·00933	2339	36·29	6329	5364	597	368	·0945	·058	·00633	·00392	84·8
2	952	·00724	2764	36·58	4491	3370	489	632	·109	·141	·00645	·00281	75·0
3	592	·00792	4145	37·38	7971	6930	748	293	·0939	·0368	·011	·00791	87·0

Some Remarks on the Figures in the Table.

Watts external, and $w\ m$, were measured simultaneously by two ammeters and a voltmeter, $w\ a$ was calculated $= \kappa\ a^2\ L\ s$ (κ taken as $9{\cdot}28 \times 10^{-6}$), and a being $= \frac{C + C_s}{2\ s}$, then was calculated

$$W = \text{watts external} + w\ a + w\ m.$$

To find V, the number of revolutions per second were multiplied into $2\ \pi\ \times$ the average diameter of the whole armature-conductor in relation to the axis of the armature. Then was calculated

$$F = \frac{W}{V\ L\ s\ a}.$$

The value of $w\ a$, as taken above, was checked by measuring the actual internal resistance by means of a Wheatstone bridge, correcting for temperature, and then take

$$w\ a = (C + C_s)^2\ r\ a;$$

C = current in external;

C_s = current in shunt.

The average diameter for the rotating conductor I take, for the Gramme ring equal to the mean of the internal and external diameters of the annular core, for a drum armature equal to

$$\frac{D + D_1}{2} \times \frac{L + \frac{1}{2}D}{L + D}$$

where L = the length, D = the diameter of the core, and D_1 = the diameter of the cylindrical part of the armature when finished.

THE PROPORTIONAL GALVANOMETER.

By Dr. R. ALLBRICHT.

THE "Proportional Galvanometer" described in the volume of this journal (*Centralblatt für Elektrotechnik* for 1883, p. 421), has been recently constructed in a somewhat modified form, which essentially facilitates its practical execution. Fig. 1 represents the instrument. In place of the two wire coils which penetrated each other at right angles there are two coils which are likewise placed at right angles to each other, but touch only at the circumference, so that each may be wrapped separately. The pivot of the needle is at the point where the axes of the two coils intersect each other. The action of the coils upon the movement of the needle remains as it was formerly described.

The introduction is, as shown in fig. 2, that of a differential galvanometer, the two branches of the current, J_1 and J_2, being conducted around the two coils, I and II, in such a manner that their magnetic momenta are as $J_1 - J_2 : 2\ (J_2 - J_1)$.

In the instrument figured, J_1 is carried over the rings, I and II, in 367 folds each. J_2 is carried in 367 folds over ring I, and in 734 folds over ring II. In order to obtain an equal distribution of the folds, the ring I, receives also 367 folds of a wire not traversed by the current. The wires are coiled in a trifilar manner.

Each branch of the galvanometer has the resistance of 100 ohms.

The rings, which are mounted upon a plate, are movable along with it upon a tripod, and are always set so that the needle is in the magnetic meridian. If the rotation required for this position is measured, whilst the introduced resistance, x, passes through the values 0 to 100 ohms, on the 45° of the chord shown in figs 1 and 2, equal resistances will correspond to equal sections of the chord. For more convenient reading, the marks of the chord, which is divided into 100 equal parts, are projected upon the circumference of the circle. This instrument permits resistances of 0 to 100 ohms to be read off with almost equal accuracy.

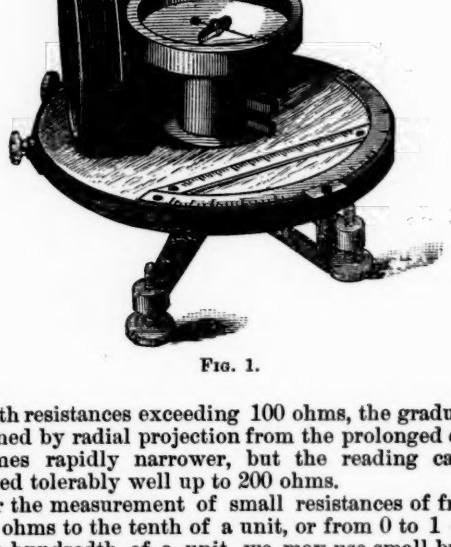


FIG. 1.

With resistances exceeding 100 ohms, the graduation obtained by radial projection from the prolonged chord becomes rapidly narrower, but the reading can be effected tolerably well up to 200 ohms.

For the measurement of small resistances of from 0 to 10 ohms to the tenth of a unit, or from 0 to 1 ohms to the hundredth of a unit, we may use small branch resistances of 100/9 or 100/99 ohm, which are introduced parallel to the galvanometer wire. The equidistant graduation of the 45° chord retains here its full validity.

The management of the instrument is convenient; its manufacture requires, however, some care, inasmuch as an incorrect placing of the coils with regard to the axis of the needle interferes with its calculated actions.

The attempt was made to put in place of the magnetic needle a rotatory wire bobbin, connected with a telephone. In place of the constant current there came into play reciprocating currents, which followed each other in rapid succession. The supposition might be entertained that the position which the coil must take up so as to produce a minimum of noise in the telephone would correspond to the position of the needle under similar circumstances, so that a telephonic measurement of resistance might have been undertaken. This conjecture, however, proved inaccurate on account of complicated inductive actions.

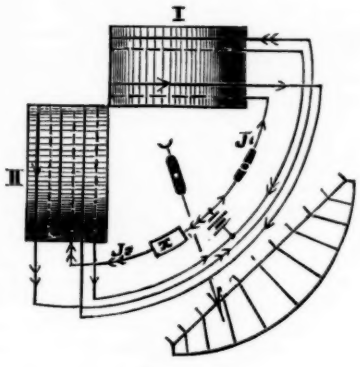


FIG. 2.

Finally, it must be mentioned that the instrument, as soon as a short circuit is formed in place of the resistance to be measured, thus annulling the effect of the ring I, can be used as a tangent galvanometer and as a sine galvanometer. Here the graduated circle comes into use, which is found immediately under the needle. The apparatus can also be used as an ordinary differential galvanometer if a position at right angles to the ring II, is selected as the zero position of the needle.

COMPOUND-WOUND DYNAMOS.

WE quote the following article upon a subject which has been mooted in our columns, as a specimen of what passes as electrical literature in the United States. We can assure our contemporary that its view of the point at issue is not likely to be adopted on this side of the water :—

"Just at present there appears to be considerable agitation among our English confreres. A bombshell has been thrown into camp by the Anglo-American Brush Company in the shape of a warning to English manufacturers against infringement of their patent for compound-winding in dynamos (No. 2,003, 1878), and, judging from the noise it has occasioned, in defence, it would be reasonable to suppose that Chinese tom-tom tactics had been adopted.

"It seems that last February the Brush Company applied to the British Patent Office for permission to file a disclaimer, which, after due examination by the authorities, was granted, notwithstanding the opposition of the Siemens Brothers and Mr. Crompton, both manufacturers of compound-wound machines. The company has issued due notice that all infringement will be promptly prosecuted, and hence the trouble.

"For the past few months the claims of the many rival claimants have been thoroughly aired through the scientific press in England until there is not room to hang a doubt upon; the matter is very simple, and yet the most absurd claims continue to be urged. The latest phase of this war of words is the attempted renovation of an old patent of Mr. S. A. Varley to fit the case; but compound-winding is one thing and compound winding *for constant electromotive force* is another. A careful perusal of the specifications of Mr. Varley's patent prove conclusively that his idea was a simulation of the operation of the magneto-electric machine, obtaining thus its advantages without likewise assuming its faults. Whereas, in the Brush patent, the object expressed is an automatic regulation of the electromotive force *per se*, with reference to varying external resistances. If these specifications do not indicate the maintenance of constant electromotive force, no matter what the external resistance, we are at loss to know what phrasing in the English language would express it.

"Mr. Varley's patent (No. 4,905), granted in 1876—if the entire context be considered, and not an extract here and there to suit a particular cause—will be found entirely foreign to the subject of constant-electromotive force machines as now constructed, both in avowed object and evident intent. This is the whole case in a nutshell, and we must aver that there has been an overabundance of the "*me too*" principle displayed in the controversy. However, we have so often, heretofore, been treated to a resurrection of the rag-babies of unsuccessful invention and vain attempts to blow animation into their almost forgotten frames, following upon the heels of practical success, that, perhaps, we should learn to expect the exhibition."

A GENERAL LAW.*

SUPPOSE that into any circuit having a resistance R and a constant E.M.F. we introduce a device having a resistance R′. Then the energy expended in this device will be

$$W = \frac{E^2}{(R + R')^2} R'.$$

Taking the first derivative

$$\frac{d\,W}{d\,R'} = E^2 \frac{(R + R')^2 - 2\,R\,R' - 2\,R'^2}{(R + R')^4} = \frac{R^2 - R'^2}{(R + R')^4} E^2.$$

Equating to zero

$$R^2 = R'^2$$

$$R = R'.$$

The second derivative being obviously negative, this result indicates a maximum. In other words, the maximum amount of energy can be secured in a device introduced into a circuit by making its resistance equal to the resistance already in the circuit.

Two very well-known consequences follow from this law.

Suppose we wish to put an electro-magnet into a circuit having already a known resistance, and that we desire to get the maximum magnetic effect out of this magnet.

Clearly its effect varies as $C\,l$, where l is the length of wire employed. Therefore the larger the wire and the longer, the greater the effect, other things being equal. But suppose the volume occupied by the coils to be fixed at as large an amount as possible under the circumstances. Then l varies as $\sqrt{R'}$, and therefore the effect varies as $C\sqrt{R'} = \sqrt{\text{energy expended}}$, since the energy expended $= C^2 R'$. Remembering the above law of maximum distribution of energy in a circuit, it follows that we get the maximum magnetic effect from any electro-magnet when we make its resistance equal to the resistance already in the circuit.

The case of an electro-motor is similar if we consider the E.M.F. as a resistance R′. Suppose the resistance of

* Lieut. B. A. Fiske, U.S. Navy, in the *Electrical World*.

the circuit, including motor, is R; then this law asserts that we will get the maximum effect from the motor when this apparent $R' = R$. Thus,

$$C = \frac{E}{R + R'} = \frac{E - e}{R}.$$

When $R' = R$,

$$\frac{E}{2R} = \frac{E - e}{R},$$

$$E = 2E - 2e,$$

$$e = \tfrac{1}{2} E.$$

In other words, the well-known cases of the magnet and the motor are simply two applications of this general law.

THE RECENT TESTS OF DYNAMOS AT PHILADELPHIA.

THE remarks of the New York *Electrical Review* respecting these tests will interest our readers, and so we append them :—" The machines of but two systems were entered ; those of the Edison and United States Electric Light Companies, the former entering four and the latter three. It was, indeed, a battle of the giants, but the Weston machines, in the end, proved too much for their opponents. The Edison dynamos acted badly from the start, and in two out of the four the armature insulations gave way before the tests were over. The 400-ampère machine No. 20, was an especial offender, as will be seen from the following quotation from the report of the committee :—'The full-load tests are marked unofficial because the preliminary run of ten hours was not on full-load. The machine was started at the usual time, midnight, with about the right load, *but in a few hours the power fell to about fifty horse-power*, and remained about the same till noon of June 19th, when *by increasing the number of revolutions* the proper load was nearly attained. The tests were to have been repeated the next day, but unfortunately the *insulation of the armature gave way*, making this impossible. The tests seem to agree quite well. It is hard to compare the first full-load measurement with the others, as the conditions were different. The two full-load measurements, made under about the same conditions, agree almost exactly.' In the above the italics are our own, and we emphasise these points in order to show the fallacy in the high total efficiency on full load, 96·51 per cent., obtained for this machine by including the result of the first test at full load made at 9·45 a.m. of the 19th, and so far under the required conditions that the committee were compelled to declare it 'unofficial,' evidently intending that it should be taken for what it was worth and no more. The speed was increased, the proper load of 400 ampères nearly attained, and the two concluding measurements made when the armature insulation gave out. If the tests of this machine are to be used at all, we fully agree with the committee in their implied recommendation to base our estimate of its efficiency, at full load, on the last two tests made under nearly the same conditions, the one at 1.30 p.m. and the other at 2.45 p.m. of the 19th. Thus we obtain an average total efficiency for this machine of 96·52 per cent., and an average for all four of the Edison machines of 95·40 per cent., but if we throw No. 20 out entirely, the average efficiency then becomes 95·05 per cent.

" The average of the Weston machines on full load for total efficiency reached the high figure of 95·81 per cent., the advantage of the latter over their competitors at one-quarter, one-half, and three-fourths load was even more marked. However, when we come to consider the point of commercial efficiences we find the Edison machines leading their rivals by a small amount, yet it is a question which experience can only answer, whether the extra resistance in bearings, &c., which Mr. Weston has introduced to secure strength, ventilation, &c., and which conduce mainly to this result, may not in the long run offset this apparent disadvantage."

The New York *Electrical World* remarks upon the same subject :—" It would be difficult to draw a distinction between the two sets of machines, as their performances are practically identical. Indeed, this was to be expected. Both have the Siemens armature, are shunt-wound, and have been the results of long and careful experiments, whence it is not strange that the results agree so closely. While the report shows what can be expected from a well-designed machine of this type, it is very much to be regretted that the machines by other makers using the Gramme and Paccinotti types of armatures were not entered for competition. We should then have been able to compare distinct types of the most recent construction. Taking the figures as they stand, they show remarkable results in the conversion of natural forces. Thus, in several instances over 96 per cent. of the total power applied to the machines was converted into electricity, and an average of nearly 90 per cent. was available for external useful work at full load. It is, of course, to be expected that with partial loads the efficiency of the machines will diminish, but even in these cases the figures are very good, showing the machines to be well designed. Comparing the present results with those obtained in Munich in 1882, we find a most marked improvement in the performance of the Edison dynamos, the only incandescent machines tested on that occasion. It will be remarked, however, that with partial loads the efficiency of the Weston machines is slightly in excess of those of Edison, and increases as the load decreases. Whether this is to be looked for in the fact that the ratio of armature to field resistances at partial loads is as a rule greater in the Edison than in the Weston machines, is an open question. It would seem, from the results, that with decreasing load, or, in other words, with increasing resistance in the external circuit, a limit is reached, beyond which added resistancce in the field prevents the proportionate magnetisation from reaching its proper limit, shown by an increase in the proportional energy in the field, and thus causing a loss of efficiency. Calculation also shows that the weights of the machines vary from about 110 to 150 pounds per electrical horse-power developed."

BRUSH ELECTRIC LIGHT SHARES.

WE (*Financial News*) have been asked by numerous correspondents if there is any reason for the recent advance in the price of the shares of the Anglo-American (Brush) Electric Light Corporation, Limited, and whether we consider them a good purchase at the present price. The only explanation of the advance that can be discovered is that some of the officials of the company, who are heavily loaded with the shares, have for some time past been predicting that the shares would go up, but without having any apparent ground for their opinion. The price of the £5 shares on which £3 are paid has this year advanced from $1\frac{1}{16}$ to £4. Whether the price has been put up for the purpose of unloading previous to the remaining £2 a share being called up, we know not, but we have no hesitation in saying that we do not consider the shares a good purchase at the present price, and for the following reasons :

The bulk of the stock of electric lighting material held by the company, and which has been carried forward from year to year in the balance-sheet as an asset, is old, and there is such an immense quantity of this stock in second hands all over the country lying idle, that it is impossible to realise at anything like remunerative figures. Only last month at the public sale of the stock-in-trade of one of the defunct companies a large quantity of Brush plant was only saleable at prices from 60 to 70 per cent. below the parent

company's list prices. At the same sale the Brush licences for the whole of the industrial counties in the North of England and the Midlands, and which cost some £40,000 to acquire, were unsaleable even at the tempting price of £100, no response being made to the auctioneer's appeal for a bid even at this figure. These facts are sufficiently suggestive of the present position of the electric lighting business without going any further into details or inquiring what has become of the string of companies called into existence by the corporation in question.

The present business of the company consists entirely of manufacturing new machines, the old ones being practically useless by reason of new patents, and selling such machines at a small working profit, the business of a small jobbing concern rather than that of a gigantic company with such costly appendages as directors, engineers, electricians, &c. If the company were to call up the remaining £2 per share and invest it in a central electric lighting station in the City, it might stand some chance of earning a dividend on the outlay, but such return would of course be insignificant when spread over its present large capital. When the company attempts to compete for new work in the country it finds itself face to face with the immense stock of Brush apparatus bought at the sales of bankrupt companies, the holders of which are only too glad to sell at half the price quoted by the Anglo-American (Brush) Electric Light Corporation, Limited.

COMPETITIVE TESTS OF DYNAMOS.

(*Continued from page* 434.)

Measurement of Current.

The currents were measured by observing the ratio of the potentials at the ends of a fixed resistance when a known current and the current to be measured were passing respectively. To do this, the terminals of a circuit containing a galvanometer and a resistance box were permanently fastened to the extremities of the fixed resistance. A current was sent through the latter, and the resistance of the box adjusted until the proper deflection of the galvanometer was obtained; the current was measured by the voltameter, tangent galvanometer, or calorimeter, and the deflection and resistance were observed. When any other current was to be measured, the box was changed until the deflection was about the same as before, and both the deflection and resistance noted. The thermometers used in getting the temperatures of the different parts of the circuit were those by Green, already described.

The notation and formulæ used are as follows:

Let c' be the current used in calibration;
r' be the resistance used in calibration;
d' be the deflection used in calibration;
t'_s be the temperature of fixed resistance at calibration;
t'_b be the temperature of resistance box at calibration;
t'_g be the temperature of galvanometer at calibration;
c'' be the current to be measured;
r'' be the corresponding resistance:
d'' be the corresponding deflection;
t''_s be the corresponding temperature of fixed resistance;
t''_b be the corresponding temperature of the box;
t''_g be the corresponding temperature of galvanometer;
t_o be the standard temperature = 25° C.;
u_g be the temperature coefficient for galvanometer circuit;
u_s be the temperature coefficient for fixed resistance and box;
G be the galvanometer resistance;
k be the constant at 25° C.

Then

$$k = \frac{c'}{2\,d'} \frac{1 + u_s\,(t'_s - t_o)}{\left[\, G\,\{1 + u_g\,(t'_g - t_o)\} + r'\,\{1 + u_s\,(t'_b - t_o)\}\,\right]}$$

$$c'' = k\,2\,d''\left[1 - u_s\,(t''_s - t_o)\right]\left[\, G\,(1 + u_g\,(t''_g - t_o)) + r''\,(1 + u_s\,(t''_b - t_o))\,\right]$$

Calculations were facilitated by making tables of

$$G\,\{1 + u_g\,(t_g - t_o)\}$$

for the different temperatures, of

$$r\,\{1 + u_s\,(t_b - t_o)\}$$

for the different resistances that were to be used, and of

$$1 - u_s\,(t_s - t_o)$$

for the different temperatures of the fixed resistance.

Galvanometer. — A mirror galvanometer, by Edelmann, of Munich, was used. It was furnished with a ring magnet damped by surrounding copper blocks. The suspension, originally about two feet long, was shortened to about seven or eight inches by a copper rod passing inside the glass suspension tube; there was no trouble from vibrations. The coils were movable on graduated bars, but for the tests they were clamped and their position never changed. The resistance of the coils, with the fixed resistance and the leads to it, was ·3973 ohms, at 25°. This was taken as G in the formulæ, and the temperature coefficient for copper used; the value of the German silver fixed resistance being only about ·0004 ohms, and the rest of the circuit being copper. The galvanometer was read with a mirror and scale, the latter being of porcelain, graduated to centimetres and millimetres. The distance from the galvanometer was 2·5 metres.

Resistance Box.—The resistance box, by Hartmann, being open at both ends and having no paraffin on the coils, was very well fitted for its work. Its measurement has been described.

Fixed Resistance.—It consisted of three strips of German silver, 4½ inches broad by ·036 inches thick, the ends hard soldered into heavy copper blocks.

One of the blocks had a terminal piece cast on it that was bent to clear the edge of the tank in which the resistance was placed, and dipped into a mercury cup, to which one of the main leads was brought. From the other block, two copper rods passing between the strips, were bent over the edge of the tank and dipped with the other main lead into another mercury cup. The terminals of the galvanometer circuit were soldered into the copper blocks and remained permanent during the tests. The whole was put in a rectangular tank filled with the same kind of oil as was used for the potential resistance.

Calibrations.—Calibrations were made by sending a current through the fixed resistance, measuring it, observing the deflection of the galvanometer and the resistance in its circuit, and noting the temperatures. The calibrations usually lasted 10 minutes. The constant was calculated by the formula already given.

Three methods of measuring current were used; the silver voltameter, tangent galvanometer and calorimeter.

Altogether, there were five calibrations by the tangent, nine by the voltameter and five by the calorimeter. The following are the values obtained:—

·024510 by voltameter.	·024481 by calorimeter.
·024510 by voltameter.	·024477 by calorimeter.
·024440 by tangent galvanometer.	·024520 by tangent.
·024550 by tangent galvanometer.	·024500 by voltameter.
·024510 by voltameter.	·024516 by voltameter.
·024480 by voltameter.	·02453 by calorimeter.
·024590 by tangent.	·024495 by voltameter.
by calorimeter.	·024494 by voltameter.
·02455 by tangent.	·02450 by calorimeter.
·02455 by voltameter.	

This principle of measuring current has been used before, notably at the Vienna and Munich Exhibitions, but as employed in the following tests the method differs from that previously used in an important particular, *i.e.*, the construction of the fixed resistance. The substitution in the fixed resistance of German silver strips in oil instead of the copper bars in air formerly employed, increased greatly both the range and accuracy of the method.

Power Measurements.

The general principle of the Tatham dynamometer is shown in fig. 2. The power applied to the shaft on which the driving pulley, D, is fixed, is transmitted to the pulley, B, to whose shaft the machine to be tested is coupled, by an endless belt, which passes over D, under the stretching pulley, S, over the weighing pulley, W, under B, over the second weighing pulley, W, under S, back to the place of starting. Each of the weighing pulleys, W, is supported in a cradle, the outer end of which is pivoted on the knife edge, F, while the inner end is supported by the link, L, C. The upper ends of the two links are fastened to the scale beam, F, F, at equal distances from and on either side of the fulcrum, F.

To calculate the power applied to the pulley, B, it is necessary to know three things: The difference of tension of the belt on the two sides of B; its effective diameter, and its number of revolutions. These will be discussed in order.

The scale beam is acted upon through the links, L, C, fastened to the cradles of the weighing pulleys, W. The tensions of the belt on the outer faces of these pulleys have no effect on the beam, since the line of effort of the belt passes through the knife edges, F. The only forces then that act on the beam are the two tensions of the belt on the inner faces of the pulleys, W, *and these are the tensions on the two sides of* B; and the links being at equal distances on either side of F, *the difference of the tensions* is recorded on the beam.

The scale beam was of steel, graduated by Brown and Sharpe into 600 divisions. With the weight used each division meant one-half pound. A small poise travelling on the weight allowed readings to be taken to $\frac{1}{100}$th of a pound.

There were two adjustments to the cradles. In the first the axis of the pulley, W, was moved by micrometer screws to such a position that the line of effort of the belt passed through the knife edges of the cradle. To show this, the pulley was chocked, a short piece of the belting hung on its outside face, and weights placed in a pan hanging to the belt. When there was no effect on the scale beam, the adjustment was accomplished.

The second adjustment determined the position of the knife edge to which the links were connected. This was moved until the beam weighed about 250 pounds correctly to within one-twentieth of a pound.

The pulley, B, was calculated to deliver 6·6 feet per revolution, but the belting used was thicker than was at first intended, and the value 6·6 should be increased by one-fourth per cent. The effective diameter of the pulley, including the thickness of the belt, was measured directly, and also calculated from the length of belt delivered by five turns of the pulley. For the latter measurement, two steel points, one of which was fitted with a micrometer screw, were fixed on a wooden rule, and their distance apart accurately determined on a standard scale. Marks were made on both the pulley and belt opposite to fixed pointers. Five revolutions were given the pulley, and the length of belt that passed the pointer was measured by the rule with the steel points, any margin being taken off by a pair of compasses. The pulley was turned both ways and the effect of stretching eliminated.

The two methods checked very closely, and gave for the delivery of the pulley 6·6 (1·0025) feet per revolution.

A very ingenious mechanical counter registered the number of revolutions. Observations could be taken each minute, and the counter recorded continuously to 1,000,000 revolutions.

Having the difference of tension on the two sides of B, its delivery per turn, and number of turns per minute, the horse-power is calculated as follows :—

$$\text{Horse-power} = \text{divs. scale beam} \times \text{no. revs.} \times \frac{6{\cdot}6\ (1{\cdot}0025)}{2 \times 33000}$$

$$\text{Horse-power} = 1{\cdot}0025 \left\{ \frac{\text{divs. scale beam} \times \text{no. turns per min.}}{10{,}000} \right\}$$

It will be seen that the only part of the friction of the dynamometer that appears in the readings is that due to the bearings of the pulley, B. By the principle of Morin, that the sum of the tensions on the two parts of a belt is constant, this friction should be the same whatever the load. In getting the power applied to a machine, after the measurements have been made with the machine coupled to the dynamometer, it was uncoupled, and the dynamometer run at the same number of revolutions, the scale beam observed, and its reading subtracted from the reading when coupled.

To avoid the uncertainty of loss due to belting, the shaft of the driven pulley, B, was coupled directly to the dynamo by a universal coupling, as shown in fig. 3. It was assumed that this would allow for any slight inexactitude in lining the dynamo and dynamometer shafts, but it is doubtful if it was of much value at the high speeds used for the tests.

In making observations, the number of revolutions and scale beam were read each minute, usually for 10 minutes. The means of the two sets were multiplied together, the product divided by 10,000, and a correction of one-fourth per cent. applied, as given in the formula.

The delicacy and range of the dynamometer were both very great. On one occasion the power absorbed by a single Weston mammoth lamp was accurately measured, while the slightest variation of the load could be at once detected. During a test, the scale beam usually floated steadily, the slight and rapid jar caused by running served to limber up the weighing apparatus and render it especially sensitive. Indeed, it would be hard to fix a limit to the accuracy with which the observations could be taken.

Mr. Tatham has published a paper,* giving the principles involved in the dynamometer, and describing its various modifications of form.

The engine used was a 10 inch × 20 inch Salem Buckeye. Its governor adjustment could be readily varied from 100 to 200 revolutions. The speed, under the steady load of a dynamo, was very uniform.

A steel boiler, loaned by the Baldwin Locomotive Works, was used. It could safely carry 150 pounds per square inch and develop 80 horse-power.

CHECKING THE DYNAMOMETER.

In order to make the tests absolutely, as well as relatively accurate, it was decided to check the work recorded by the dynamometer against an amount of work calculated from the mechanical equivalent of heat.

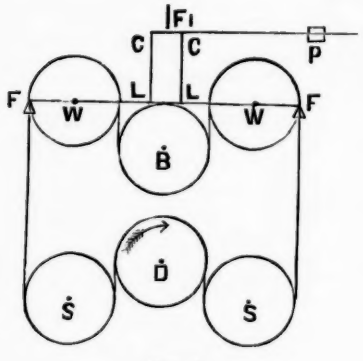


FIG. 2.

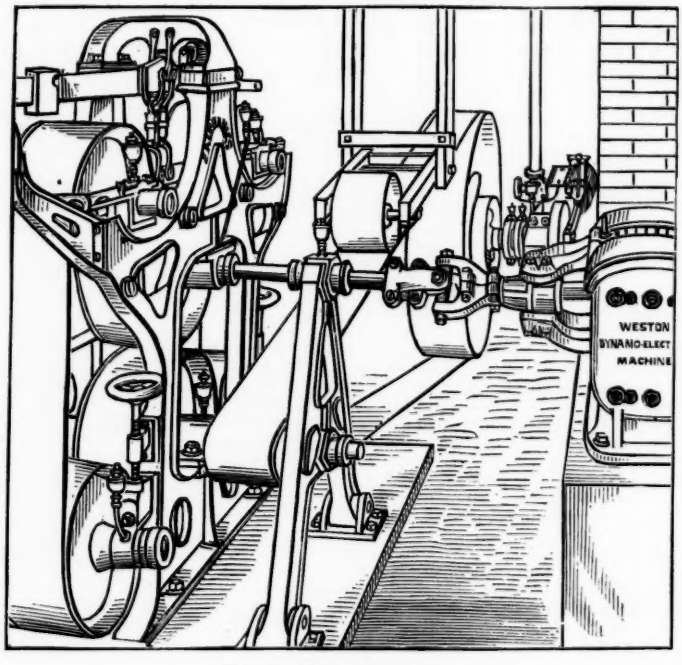


FIG. 3.—UNIVERSAL COUPLING.

To do this, a calorimeter was constructed, the general plan of which is shown in side and end section in figs. 4 and 5.

It was of wrought iron, 3 feet long by three feet in diameter, the V-shaped projections riveted inside the shell. The paddles, 30 inches long by ¼ inch thick, were keyed to the shaft and moved between the V's. One end of the shaft passed through the end of the calorimeter, and was coupled to the dynamometer. In the experiments but one paddle was used, 700 revolutions absorbing about 45 horse-power.

Two different methods of experiment were employed; first, with a constant weight of water and an increasing temperature; and second, with a constant temperature and a continuous flow of water through the calorimeter.

First Method.—In the first method, the calorimeter was filled and its water equivalent found, the engine was then started, and the rise of temperature was noted and the dynamometer observed. The mechanical equivalent was calculated from the work recorded by the dynamometer, the water equivalent of the calorimeter and the rise of temperature, the necessary corrections being applied to the latter. The value thus obtained was compared with the values of Joule and Rowland.

In getting the water equivalent, the calorimeter was first weighed empty and then when filled with water. The difference gave the weight of the water, and the water equivalent of the iron was calculated from its weight and specific heat. It was intended to determine by experiment the specific heat of the speci-

* *Journal Franklin Institute*, December, 1882. Vol. CXIV.

mens of the iron used in the calorimeter, but circumstances made this impossible. The value used, ·112, is taken from determinations by Bystrom, Weinhold, Regnault and Bede, reduced to 30° C. The values given by these different experimenters agree very well, and it seems probable that the mean does not differ from the specific heat of the iron used in the calorimeter by more than one or two per cent. at the most—an error that enters as about one-tenth in the result.

The weighings were made with a scale beam by Fairbanks. Both the weights and graduation had been tested.

Temperature Observations.—The thermometers used were those by Green, already described. The time the mercury crossed each half degree was observed and was taken as the mean of the times of crossing the tenths below and above the division, and the division itself. The times were noted by a chronometer.

Second Method.—In this method water was made to flow continuously through the calorimeter. The engine was run until the temperature of the exit water ceased to rise, and then observations of the entrance and exit temperatures and of the dynamometer were taken each minute, and the exit water weighed every four minutes. The weighings were made by two of Fairbanks's platform scales that had been tested with standard weights. The observations lasted 1½ hours. The heat units were calculated for each interval of four minutes, and their sum taken for the whole interval. The scale reading and number of revolutions of the dynamometer were averaged for the time of the experiment, the work being calculated from the means (Philadelphia time).

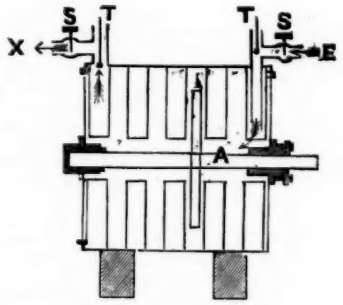


FIG. 4.

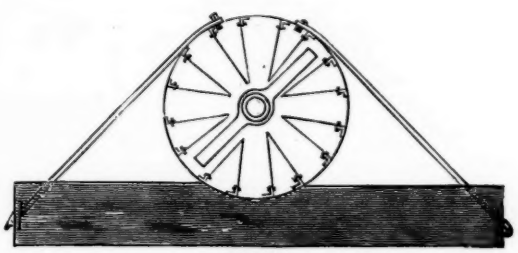


FIG. 5.

In this method the uncertainty due to the specific heat of the iron and its temperature is avoided. The greatest possibilities of error are in the mean temperature of the calorimeter and the stem correction. It is probable that too great a value of the latter has been taken; for the thermometers were in the water for several hours and a considerable portion of the stem must have been heated by conduction.

The coefficient of radiation was taken from the first experiment.

The results of the experiments are:

First method mech. eq. = 768·3 + an indeterminate correction;

Second method mech. eq. = 772·81.

It would seem then that within the limit of error of these experiments, the dynamometer is correct, and, considering the probable accuracy of the last method, there seems little doubt that the work calculated from the dynamometer readings is as accurate as the adjustments of the machine and the readings themselves.

TESTS.

For the full load tests, the machines were run at least 10 hours before any measurements were made. They were then tested at intervals of from one to two hours.

For the partial loads, the dynamos were run on quarter load for two or three hours, then tested, then run on half load for a couple of hours, and tested, &c.

The method of making a test was as follows: A time to begin was set, and the observers got ready to start at the signal from the test house. After the signal, double readings of the potential and current galvanometers were simultaneously made each minute, and the scale beam and number of revolutions of the dynamometer observed. The field galvanometer was reversed, and read as often as possible, usually four or five double readings.

At the end of ten minutes, a signal to stop was made; the dynamo was stopped, the field circuit broken, the storage battery put on, and the armature resistance measured. The brushes were then lifted, and the field circuit made and its resistance measured. Finally, the constants of the current and potential galvanometers were checked on the German silver strips.

When the tests for the day were finished, the friction of the armature and of the dynamometer were obtained, and the latter subtracted from the power applied for each test.

Communication from the test house to the dynamo shed was by an electric bell, and through a speaking tube.

The following notation will be used in the formulæ:

- e difference of potential between terminals of dynamo;
- E total electromotive force generated in armature;
- i current in external circuit;
- i_s current in field;
- R resistance of external circuit;
- r_a resistance of armature coils;
- r_s resistance of field with box for adjustment;
- s resistance of field alone;
- W energy applied in horse-power;
- W_t total electrical energy in horse-power;
- W_e energy in external circuit in horse-power;
- W_a energy in armature in horse-power;
- W_s energy in field in horse-power;
- $\mathrm{E}\,f_t$ total efficiency of electrical conversion;
- $\mathrm{E}\,f_c$ useful commercial efficiency;
- η $= \mathrm{E}\,f_c \,/\, \mathrm{E}\,f_t$;
- p_a percentage of power used in armature;
- p_s percentage of power used in field;
- n number of revolutions per minute;
- *Fric.* friction of armature;
- t_a temperature of the air in degrees centigrade;
- t_p temperature of pole piece in degrees centigrade;

Of these, e, i, i_s, r_a, s, W, n, t_a and t_p were observed directly.

E was calculated from $\mathrm{E} = e + (i + i_s)\, r_a$;

R was obtained from $\mathrm{R} = e \,/\, i$;

r_s was from $r_s = e \,/\, i_s$; it was also checked by observation after each test.

The other formulæ used were

$$\mathrm{W}_t = \frac{(i + i_s)\, e + (i + i_s)^2\, r_a}{745{\cdot}3};$$

$$\mathrm{W}_e = \frac{i\, e}{745{\cdot}3};$$

$$\mathrm{W}_a = \frac{(i + i_s)^2\, r_a}{745{\cdot}3};$$

$$\mathrm{W}_s = \frac{i_s\, e}{745{\cdot}3};$$

$$\mathrm{E}\,f_t = \frac{\mathrm{W}_t}{\mathrm{W}};$$

$$\mathrm{E}\,f_c = \frac{\mathrm{W}_e}{\mathrm{W}};$$

$$\eta = \frac{\mathrm{E}\,f_c}{\mathrm{E}\,f_t};$$

$$p_a = \frac{\mathrm{W}_a}{\mathrm{W}};$$

$$p_s = \frac{\mathrm{W}_s}{\mathrm{W}}.$$

EDISON No. 5 DYNAMO.

Diameter of armature ...	$7\frac{1}{16}$ inches inner;	$7\frac{7}{8}$ inches outer.
Weight of machine	2,475	pounds.
Number of commutator bars	50	
Turns of wire in a coil	2	
Length of useful wire in a coil	52	inches.
Brushes adjusted or not?		yes.
Diameter of bearing	$1\frac{5}{16}$	inches.
Length of bearing	$5\frac{5}{8}$	inches.
Revolutions per minute	1,400	
Volts for best work	125	
Ampères for best work	100	

Table I gives the result of the measurements.

This was the first machine tested, and the measurements were intended as much to show any weak points in the method as to serve as a test of the dynamo. If no trouble occurred, the work was to be accepted, otherwise it would have been repeated after the causes of error had been removed.

On looking at the table, it will be seen that the efficiencies for the two tests differ by about one per cent. The agreement of the measurements of the current and potentials as shown in the values of the resistances, calculated from them, is very good. Whether the difference is due to the power measurements, or to different conditions of lubrication, velocity, &c., is impossible to say.

After the second test, the insulation of the armature gave way, making it impossible to repeat the full load measurements, or to test on the partial loads.

TABLE I.—(*Edison No. 5 Dynamo.*)

Date.	May 29th.		
Time	12.40	1.40	3·00
Load	Full.	Full.	
E.M.F. at terminals ...	125·2	121·59	
Total E.M.F.	131·5	128·00	
Current in ext. circ. ...	100·92	98·06	
Current in field ...	2·385	2·296	
External resistance ...	1·241$_d$	1·240$_d$	
Armature resistance ...	·0613	·0638	
Field, with box ...	52·59	53·08	
Field, alone	...	...	
Power applied	18·89	18·05	
Total elect. energy ...	18·23	17·24	
Ext. elect. energy ...	16·95	16·00	
Energy in arm. ...	·878	·863	
Energy in field ...	·401	·374	
Total efficiency ...	96·53	95·49	
Commercial efficiency...	89·76	88·63	
Economic coefficient ...	92·99	92·82	
% power in arm. ...	4·65	4·78	
% power in field ...	2·12	2·08	
No. revolutions ...	1400·8	1389·7	
Friction of arm. ...	...	...	
Temp. of air	26·4° C.	27·° C.	
Temp. of pole-piece ...	44·° C.	45·4° C.	

Insulation of armature gave way.

EDISON NO. 10 DYNAMO.

Diameter of armature ...	$9\frac{1}{16}$ inches inside; $10\frac{5}{8}$ inches outside.
Weight of machine	4710 pounds.
Number of commutator bars	64
Turns of wire in a coil	1
Length of useful wire in a coil	33 inches.
Must brushes be adjusted?	yes.
Diameter of bearing	$2\frac{3}{8}$ inches.
Length of bearing	$9\frac{5}{8}$ „
Number turns per minute	1200
Volts for best work	125
Ampères for best work	200

Table II. gives the results of the measurements:—

There is little to say of the full load measurements of this machine. The extreme difference is about one-half per cent.; the greatest difference from the mean one-fourth per cent.

The dynamo was measured twice on the partial loads. The first set was on the same day as the full load tests, the machine being run on open circuit for a couple of hours after the last full load measurement, then tested for quarter load, then run on half load for a while and tested, &c. The second set, made some days later, showed that the machine had not been sufficiently cooled for the first set of measurements. The total efficiencies, calculated from the two sets of measurements, differ for the quarter load about one and one-half per cent.; for the half load, three-quarters per cent., and for the three-quarter load, one-seventh per cent.

In comparing these total differences, if the difference of armature friction (·152 horse-power) be applied to the first set, we get

	¼ load.	½ load.	¾ load.
First set ...	83·10	90·51	92·83
Second set ...	83·32	90·55	92·44

But as the measurement of friction was made after the three-quarter load in each case, the values for this load should agree better than for the others. Part of the difference of ·39 per cent. is undoubtedly due to the fact that in the last set of measurements the unsteadiness of the potential galvanometer while measuring the armature resistance, due to changes in the contact resistance of the brushes, was so great that the brushes were held against the commutator, thus giving too small a value of r_a, and therefore of $\mathrm{E}\,f_t$. On the whole, the agreement of the two sets is very satisfactory.

WESTON NO. 7 M. DYNAMO.

Diameter of armature	$9\frac{3}{4}$ inches.
Weight of machine	3300
Number of commutator bars... ...	64
Total number of turns in coils ...	128
Turns per commutator segment ...	2
Average length of a turn	6 feet 8 inches.
Must brushes be adjusted?	slightly.
Diameter of bearing, pulley end ...	2 inches.
Diameter of bearing, commutator end	$1\frac{1}{4}$ „
Length of bearing, pulley end ...	$7\frac{1}{4}$ „
Length of bearing, commutator end	$6\frac{1}{2}$ „
Number of turns per minute... ...	1050
Volts for best work	160
Ampères for best work	125

Table III. gives the results of the measurements.

As stated under "potential measurements," there was a sharp change in the value of the constant of the potential galvanometer between the second and third tests. The following are the calibrations made:

Time.	Value of K_{50}.	METHOD.
A.M.	at 25 deg.	
10·00	1·305	Voltameter with standard resistance.
11·35	1·307	Current galvanometer with German silver strips.
P.M.		
12·50	1·308	Current galvanometer with German silver strips.
2·50	1·287	Current galvanometer with German silver strips.
3·05	1·286	Voltameter with standard resistance.
4·15	1·286	Voltameter with standard resistance.

For the first two tests, the value 1·306 was used; for the last two, 1·286.

The tables show a gradual decrease in the efficiencies, the difference between the first and last values being about one per cent.

The cause seems to be the different amounts of lead given the brushes. If we compare the first with the third test, it will be seen that, with about the same current in the field and a greater number of revolutions of the armature, the E.M.F. of the latter test is about five volts less than that of the former. In the last test, with the speed still further increased and with the field current about constant, the E.M.F. is slightly less than in the third measurement.

The partial load tests were made after the constant had become steady. After the three-quarter load test, a measurement was made on full load. As it was not made under the provisions of the code, it is marked "unofficial" in the table. The half load test was repeated to check the former measurement. The difference of ·3 per cent. in the total efficiencies is probably accounted for by the slight increase of armature friction caused by running on the three-quarter load. The greatest value of the commercial efficiency is on three-quarter load, the slightly less value of the total efficiency, as compared with the full load, being more than counter-balanced by the smaller loss in the armature and field.

WESTON NO. 6 M. DYNAMO.

Diameter of armature	$8\frac{1}{32}$ inches.
Weight of machine	2000
Number of commutator bars	72
Total number of turns	144
Turns per commutator segment	2
Average length of a turn	6 feet 5 inches.
Must brushes be adjusted? ...	slightly.
Diameter of bearing, pulley end... ...	$1\frac{5}{8}$ inches.
Diameter of bearing, commutator end ...	$1\frac{3}{8}$ „
Length of bearing, pulley end	$6\frac{3}{4}$ „
Length of bearing, commutator end ...	5 „
Number of turns per minute	1150
Volts for best work...	120
Ampères for best work	80

Table IV. gives the results of the measurements.

The full load measurements probably agree as closely as the conditions of the tests. There was a good deal of sparking at the brushes, and the machine seemed overloaded.

For the partial loads, the total efficiency increased up to the three-quarter load, and there was little sparking at the commutator. On the unofficial full load test, the sparking was quite violent, and the efficiency fell about two per cent. from the three-quarter load. Comparing the unofficial full load with the tests of the day before, and applying the difference of armature friction to the former, it will be seen that the total efficiency for the unofficial test is less, the load being greater and the efficiency at this load decreasing rapidly as the load increases.

EDISON NO. 4 DYNAMO.

Diameter of armature,	$6\frac{1}{4}$ inches inside, $7\frac{1}{16}$ inches outside.
Weight of machine	1470
Number of commutator bars	50
Turns in one coil	2
Length of useful wire in a coil	48 inches
Must brushes be adjusted?	yes.
Diameter of bearing	$1\frac{1}{4}$ inches
Length of bearing	$6\frac{1}{4}$ „
Turns per minute	1600
Volts for best work	125
Ampères for best work	80

Table V. gives the results of the measurements.

This machine was not coupled directly to the dynamometer, the high speed required being deemed unsafe. It was run by a belt from a pulley on the transmission shaft of the dynamometer. In allowing for the loss due to the belt, it was assumed that for the full load the friction of the armature was the same as that of the No 5 dynamo.

The full load tests agree very closely, the total efficiencies increasing slightly with the horse-power. The commercial efficiencies differed very little.

The measurements on the partial loads are perhaps a little low, as it is probable that sufficient allowance was not made for the belt. The temperature was much lower than for the full load tests and the belt was probably stiffer.

TABLE II.—(*Edison No. 10 Dynamos.*)

Date.	June 1st.				June 1st.			June 4th.		
Time	12.33	2.00	3.15	4.15	6.56	7.45	8.30	11.15	2·35	4.00
Load	Full.	Full.	Full.	Full.	¼	½	¾	¼	½	¾
E.M.F. at terminals ...	125·08	122·67	121·58	122·87	125·41	126·09	122·89	127·81	128·83	125·6
Total E.M.F.	129·35	127·18	126·05	127·27	126·81	128·74	126·85	128·73	130·67	128·33
Current in ext. circ. ...	201·48	196·51	194·56	196·48	52·07	107·05	150·60	51·81	103·79	149·92
Current in field ...	4·021	3·900	3·84	3·93	3·46	3·69	3·74	3·47	3·81	3·81
External resistance* ...	·6208$_e$	·6243$_e$	·6249$_e$	·6254$_e$	2·408$_d$	1·177$_d$	·8160$_d$	2·467$_d$	1·213$_d$	·8378
Armature resistance ...	·0208	·0225	·0231	·0220	·0253	·0239	·0256	·0167	·0171	·0178
Field, with box ...	31·10	31·46	31·63	31·27	36·24	34·14	32·83	36·82	33·83	33·01
Field, alone	...	...	...	...	...	...	...	...	...	...
Power applied... ...	37·69	35·98	35·53	36·19	11·556	21·30	28·46	11·459	20·83	28·64
Total elec. energy ...	35·67	34·20	33·58	34·22	9·449	19·13	26·27	9·548	18·86	26·47
Ext. elec. energy ...	33·81	32·34	31·74	32·66	8·762	18·11	24·83	8·884	17·94	25·27
Energy in arm. ...	1·178	1·212	1·218	1·182	·105	·393	·820	·0686	·265	·564
Energy in field ...	·675	·642	·627	·648	·582	·625	·617	·595	·658	·641
Total efficiency ...	94·61	95·04	94·52	94·56	81·77	89·80	92·30	83·32	90·55	92·44
Commercial efficiency	89·70	89·89	89·34	89·52	75·82	85·02	87·25	77·53	86·12	88·23
Economic coefficient ...	94·80	94·58	94·51	94·65	92·73	94·68	94·53	93·05	95·10	95·45
% power in arm. ...	3·12	3·36	3·43	3·26	·906	1·85	2·88	·598	1·28	1·97
% power in field ...	1·80	1·79	1·76	1·78	5·04	2·93	2·16	5·20	3·16	2·24
No. revolutions ...	1208·6	1197·6	1193·3	1199·3	1207·6	1207·7	1202·6	1211·7	1211·1	1209·3
Friction of arm. ...	·437	·437	·437	·437	·437	·437	·437	·285	·285	·285
Temp. of air	30·5° C.	30·5° C.	30·5° C.	28·° C.	26·5° C.	27·5° C.	27·0° C.	25·5° C.	28·5° C.	31·0° C.
Temp. of pole-piece ...	50·5° C.	50·°5 C.	51·5° C.	56·5° C.	35·5° C.	44·5° C.	44·0° C.	38·0° C.	45·6° C.	46·7° C.

* The suffix "e" refers to lamps and "d" to "dead" resistance.

TABLE III.—(*Weston No. 7 M. Dynamo.*)

Date.	June 8th.				June 12th.				
Time	11.15	12.26	2·27	3.45	12.00	2.00	3.45	4.30	6·00
Load	Full.	Full.	Full.	Full.	¼	½	¾	Full.*	¼
E.M.F. at terminals ...	156·07	154·84	151·42	151·22	163·66	163·41	163·93	166·48	167·60
Total E.M.F....	165·58	163·99	160·79	160·31	166·07	168·29	172·65	176·30	172·77
Current in ext. circ.... ...	125·78	124·86	123·13	123·57	33·26	66·27	99·25	133·82	67·68
Current in field	2·378	2·340	2·341	2·332	1·738	1·872	2·163	2·439	1·959
External resistance	1·241$_d$	1·240$_d$	1·230$_e$	1·224$_e$	4·921$_d$	2·466$_d$	1·652$_d$	1·244$_d$	2·476$_d$
Armature resistance ...	·0742	·0720	·0747	·0722	·0689	·0716	·0683	·0720	·0742
Field, with box	65·62	66·18	64·70	64·86	94·16	87·31	75·78	68·25	85·54
Field, alone	...	...	...	...	...	...	...	...	...
Power applied	29·29	29·01	28·07	28·17	8·658	16·223	24·123	33·257	17·08
Total elec. energy	28·47	27·98	27·07	27·08	7·798	15·387	23·25	32·23	16·144
Ext. elec. energy	26·34	25·94	25·02	25·07	7·304	14·53	21·83	29·89	15·22
Energy in arm.	1·635	1·562	1·578	1·536	·1131	·446	·943	1·796	·483
Energy in field	·498	·486	·476	·473	·382	·410	·476	·545	·441
Total efficiency	97·21	96·48	96·45	96·12	90·08	94·84	96·38	96·92	94·52
Commercial efficiency ...	89·92	89·42	89·14	89·00	84·37	89·57	90·49	89·87	89·12
Economic coefficient ...	92·51	92·68	92·41	92·58	93·65	94·41	93·90	92·73	94·28
% power in arm.	5·59	5·39	5·63	5·45	1·31	2·75	3·91	5·40	2·82
% power in field	1·70	1·68	1·69	1·68	4·41	2·53	1·98	1·63	2·58
No. revolutions	1043·5	1039·0	1045·6	1051·7	1041·4	1038·8	1024·1	1058·8	1051·3
Friction of arm.	·3115	·3115	·3115	·3115	·1956	·1956	·1956	·1956	·1956
Temp. of air	30·° C.	30·5° C.	30·° C.	30·° C.	29·5° C.	31·° C.	30·5° C.	29·° C.	28·° C.
Temp. of pole-piece... ...	42·° C.	42·2° C.	42·8° C.	47·8° C.	33·3° C.	35·° C.	36·5° C.	36·° C.	35·5° C.

* Unofficial.

TABLE IV.—(*Weston No. 6 M. Dynamo.*)

DATE.	June 13th.				June 14th.			
Time	11.52	1.50	2.25	3.55	12.15	2.20	4.00	4.39
Load	Full.	Full.	Full.	Full.	¼	½	¾	Full.*
E. M. F. at terminals ...	117.4	115·4	118·89	119·86	119·70	122·41	119·19	124·41
Total E. M. F.	124·59	122·37	126·26	127·17	121·70	126·28	125·12	131·76
Current in ext. circ. ...	71·85	70·62	72·45	71·56	20·535	39·878	60·705	75·65
Current in field	1·277	1·254	1·280	1·286	1·236	1·214	1·246	1·318
External resistance	1·643$_d$	1·634$_d$	1·641$_d$	1·675$_e$	5·827$_e$	3·070$_e$	1·963$_d$	1·645$_d$
Armature resistance ...	·0983	·0969	·0999	·1003	·0921	·0940	·0957	·0956
Field with box	91·93	92·00	92·91	83·20	96·79	100·9	95·09	94·42
Field alone	...	...	...	...	...	...	...	...
Power applied	12·89	12·48	13·15	13·17	3·979	7·341	10·774	14·390
Total elect. energy	12·23	11·80	12·49	12·429	3·554	6·962	10·40	13·606
Ext. elect. energy	11·32	10·93	11·56	11·508	3·297	6·55	9·708	12·627
Energy in arm.	·705	·672	·729	·714	·0585	·213	·493	·759
Energy in field	·201	·194	·204	·207	·1985	·1993	·1992	·2199
Total efficiency	94·82	94·53	94·98	94·37	89·33	94·84	96·53	94·55
Commercial efficiency ...	87·79	87·59	87·88	87·38	82·87	89·23	90·10	87·75
Economic coefficient ...	92·58	92·66	92·53	92·59	92·77	94·08	93·34	92·80
% power in arm.	5·48	5·38	5·56	5·43	1·47	2·90	4·58	5·28
% power in field	1·56	1·56	1·56	1·57	4·99	2·71	1·85	1·53
No. revolution	1099·6	1101·9	1117·8	1114·9	1110·7	1109·5	1113·7	1154·2
Friction of arm.	·298	·298	·298	·298	·1672	.1672	·1672	·1672
Temp. of air	30·4° C.	31·° C.	30·5° C.	30·5° C.	34·° C.	33·5° C.	...	...
Temp. of pole-piece	37·7° C.	41·2° C.	41·6° C.	41·5° C.	36·7° C.	39·5° C.	...	...

* Unofficial.

TABLE V.—(*Edison No. 4 Dynamo.*)

DATE.	June 16th.				June 17th.			
Time	2.16	3.30	4.25	5.20	11.00	12.15	2.15	2·40
Load	Full.	Full.	Full.	Full.	¼	½	¾	Full.*
E. M. F. at terminals ...	120·05	124·95	125·20	126·75	128·66	128·77	128·39	131·17
Total E. M. F.	124·64	129·61	129·97	131·91	130·00	131·09	132·22	137·08
Current in ext. circ. ...	72·919	75·93	76.12	82·10	22·36	39·55	63·58	90·68
Current in field	1·915	2·244	2·211	2·321	1·940	2·082	2·222	2·647
External resistance... ...	$1{\cdot}646_d$	$1{\cdot}646_d$	$1{\cdot}647_d$	$1{\cdot}543_e$	$5{\cdot}755_e$	3.256_d	$2{\cdot}019_e$	$1{\cdot}446_e$
Armature resistance ...	·0614	·0596	·0610	·0611	·0550	·0556	·0582	·0634
Field, with box	62·68	55·68	56·63	54·58	66·33	61·85	57·78	49·55
Field, alone	44·17	44·46	44·69	44·59	40·42	41·21	42·29	...
Power applied	13·284	14·383	14·442	15·786	5·050	8·168	12·517	18·053
Total elect. energy	12·51	13·60	13·64	14·93	4·237	7·322	11·67	17·17
Ext. elect. energy	11·746	12·73	12·77	13·95	3·859	6·833	10·95	15·96
Energy in arm.	·461	·488	·501	·584	·0436	·129	·338	·741
Energy in field	·309	·376	·371	·394	·335	·360	·382	·466
Total efficiency	94·21	94·53	94·47	94·58	83·89	89·65	93·26	95·09
Commercial efficiency ...	88·42	88·52	88·43	88·38	76·40	83·65	87·50	88·40
Economic coefficient ...	93·85	93·64	93·61	93·45	91·07	93·32	93·82	92·97
% of power in arm.	3·47	3·40	3·47	3·70	·86	1·59	2·70	4·10
% of power in field	2·32	2·61	2·57	2·49	6·63	4·41	3·06	2·58
No. Revolutions	...	...	...	...	...	...	...	...
Friction of arm.	·14	·14	·14	·14	·16	·16	·16	·16
Temp. of air	35·5° C.	36·5° C.	36·2° C.	36·° C.	21·° C.	23·° C.	25·° C.	24·8° C.
Temp. of pole-end	45·8° C.	45·5° C.	46·1° C.	45·5° C.	27·2° C.	29·5° C.	33·3° C.	34·6° C.

* Unofficial.

TABLE VI.—(*Edison No. 20 Dynamo.*)

Date.	June 18th.			June 19th.			
Time	1.00	2.25	3.50	9.45	1.30	2.45	4.00
Load	¼	½	¾	Full.*	Full.*	Full.*	
E.M.F. at terminals ...	126·16	122·0	123·99	105·95	125·04	125·4	
Total E.M.F.	127·46	124·10	127·55	110·00	129·60	129·95	
Current in ext. circ. ...	100·22	192·46	291·16	330·88	387·28	379·00	
Current in field	4·942	4·915	5·124	4·397	5·136	5·124	
External resistance ...	$1{\cdot}258_d$	$·6338_d$	$·4161_d$	$·3202_d$	$·3229_d$	$·3308_e$	
Armature resistance ...	·0124	·0106	·0120	·0121	·0116	·0119	Armature insulation gave way.
Field, with box	25·53	24·82	24·20	24·10	24·35	24·47	
Field, alone	...	...	...	...	...	...	
Power applied	20·254	35·43	53·11	51·06	70·72	69·39	
Total elec. energy ...	17·985	32·86	50·71	49·48	68·25	66·97	
Ext. elec. energy	16·965	31·50	48·44	47·04	64·99	63·76	
Energy in arm.	·1838	·556	1·416	1·82	2·40	2·35	
Energy in field	·837	·809	·852	·625	·862	·862	
Total efficiency	88·80	92·77	95·46	96·91	96·51	96·52	
Commercial efficiency ...	83·76	88·93	91·19	92·11	91·90	91·89	
Economic coefficient ...	94·33	95·86	95·53	95·06	95·22	95·21	
% power in arm.	·91	1·57	2·66	3·57	3·39	3·38	
% power in field	4·13	2·27	1·61	1·23	1·22	1·25	
No. revolutions	1008·9	1023·9	1008·8	1022·3	1092·1	1090·2	
Friction of arm.	...	...	...	·393	·393	·393	
Temp. of air	28·5° C.	28·5° C.	28·5° C.	31·5° C.	33·° C.	33·5° C.	
Temp. of pole-piece ...	35·0° C.	37·8° C.	38·3° C.	44·5° C.	45·° C.	47·8° C.	

TABLE VII.—(*Weston No. 6 W. I. Dynamo, 130 Volts.*)

Date.	June 22nd.		June 23rd.				
Time	...	2.00	12.40	2.20	3.35	4.35	5·35
Load	¼	½	Full.*	Full.	Full.	Full.	¾
E.M.F. at terminals	125·06	124·29	128·45	129·00	124·8	131·8	133·7
Total E.M.F.	126·17	126·34	133·12	133·87	129·89	136·22	137·19
Current in ext. circ.	25·51	46·19	108·94	109·29	114·2	98·33	81·99
Current in field...	2·051	2·144	2·239	2·213	2·171	2·272	2·242
External resistance	$4{\cdot}901_d$	$2{\cdot}691_d$	$1{\cdot}180_d$	$1{\cdot}180_d$	$1{\cdot}093_e$	$1{\cdot}340_e$	$1{\cdot}630_e$
Armature resistance	·0404	·0424	·0420	·0437	·0438	·0439	·0441
Field, with box...	60·96	57·96	57·37	58·28	57·51	58·01	59·62
Field, alone	...	...	...	...	...	...	...
Power applied	5·092	8·820	20·98	20·71	21·01	19·28	16·48
Total elec. energy	4·666	8·193	19·86	20·03	20·29	18·39	15·50
Ext. elect. energy	4·281	7·703	18·78	18·92	19·13	17·39	14·70
Energy in arm....	·0412	·1329	·697	·729	·795	·596	·394
Energy in field	·344	·358	·386	·383	·364	·402	·402
Total efficiency	91·64	92·89	94·68	96·69	96·53	95·39	94·06
Commercial efficiency	84·07	87·32	89·51	91·32	91·02	90·21	89·22
Economic coefficient	91·74	94·01	94·54	94·45	94·29	94·57	94·86
% power in arm.	·81	1·51	3·32	3·52	3·78	3·09	2·39
% power in field	6·76	4·05	1·84	1·85	1·73	2·09	2·44
No. revolutions...	1167·2	1168·3	1258·5	1267·6	1250·6	1257·6	1252·3
Friction of arm.	...	...	...	·13	·13	·13	·13
Temp. of air	31·° C.	31·° C.	27·5° C.	27·5° C.	25·° C.	25·7° C.	...
Temp of pole-piece	35·° C.	37·° C.	35·5° C.	35·5° C.	36·7° C.	36·7° C.	...

* Rejected.

TABLE VIII.—(*Table of Efficiencies.*)

	Volts.	Ampères.	Weight.	Total Efficiencies.				Commercial Efficiencies.			
				Full Load.‡	¾ Load.	½ Load.	¼ Load.	Full Load.‡	¾ Load.	½ Load.	¼ Load.
Edison No. 4	125	80	1,470 lbs.	94·45	93·26	89·65	83·89	88·44	87·40	83·65	76·40
Edison No. 5* ...	125	100	2,475 lbs.	96·01	...	...	...	89·19	...	...	...
Edison No. 10	125	200	4,710 lbs.	94·68	92·44	90·55	83·32	89·61	88·23	86·12	77·53
Edison No. 20* ...	125	400	8,331 lbs.	96·65†	95·46	92·77	88·80	91·96†	91·19	88·93	83·76
Weston 6 M.	120	80	2,000 lbs.	94·67	96·53	94·84	89·33	87·66	90·10	89·23	82·87
Weston 7 M.	160	125	3,300 lbs.	96·56	96·38	94·84	90·08	89·37	90·49	89·57	84·37
Weston 6 W. I. ...	130	100	2,100 lbs.	96·20	94·06	92·89	91·64	90·85	89·22	87·32	84·07

* Armature insulation gave way. † Unofficial. ‡ Average of full load measurements.

EDISON NO. 20 DYNAMO.

Diameter of armature, 9 11/16 inches inside, 10⅜ inches outside.	
Weight of machine	8331 pounds.
Number of commutator bars	44
Turns of wire in a coil	1
Length of useful wire in a coil	59 inches.
Must brushes be adjusted?	yes.
Diameter of bearing	2¾ inches.
Length of bearing	10¾ „
Number of turns per minute	1000
Volts for best work	125
Ampères for best work	400

Table VI. gives the results of the measurements.

The full load tests are marked unofficial, because the preliminary run of ten hours was not on full load. The machine was started at the usual time, midnight, with about the right load, but in a few hours the power fell to about fifty horse-power, and remained about the same until noon of June 19th, when by increasing the number of revolutions, the proper load was nearly attained. The tests were to have been repeated the next day, but unfortunately the insulation of the armature gave way, making this impossible.

The tests seem to agree quite well. It is hard to compare the first full load measurement with the others as the conditions were different. The two full load measurements made under about the same conditions agree almost exactly.

WESTON NO. 6 W. I. DYNAMO.

Diameter of armature	8¼ inches.
Weight of machine	2100 pounds.
Number of commutator bars	56
Total number of turns in armature coils ...	112
Turns per commutator segment	2
Average length	6 feet 3¼ inches.
Must brushes be adjusted?	slightly.
Diameter of bearing, pulley end	1⅝ inches.
Diameter of bearing, commutator end ...	1⅝ „
Length of bearing, pulley end	6¾ „
Length of bearing, commutator end ...	5 „
Turns per minute	1200
Volts for best work	130
Ampères for best work	100

Table VII. gives the results of the measurements.

The values of the total efficiency for the different measurements of this machine differ widely. The first test gives a much smaller value than the rest, and is rejected, because, whether the difference is caused by errors in the measurements, or in the adjustment of the machine, the test evidently does not represent the normal efficiency of the dynamo.

Table VIII. gives a summary of the tests.

In the table, the full load efficiencies of the Edison No. 20 dynamo are marked "unofficial," because the preliminary run was not in conformity with the code, not because there is any reason to mistrust the results.

Of the 54 measurements made, four were for obvious reasons deemed unworthy of calculation. These were two tests of the Edison No. 5 dynamo, and a couple of partial load tests of the Weston No. 7 M machine, made while the constant of the potential galvanometer was unsteady. Of the remaining 50 tests, but one is rejected—a full load measurement of the Weston 6 W. I. dynamo.

Considering the care taken in standardising all of the instruments used in the measurements, and the very close agreement of tests made on the same dynamo, it seems probable that the results given in the above table represent very nearly the efficiencies of the machines under the conditions of the tests.

The dynamos were favoured by being coupled directly to the dynamometer, and it will be seen on looking at the tables that the loss by friction was slight.

In the measurements, the ohm was taken at 106 centimetres of mercury, so in order to reduce the values to absolute measure the potentials, and, therefore, the efficiencies, should be reduced by about one-fourth per cent.

NOTES.

The Electric Lighting at Lincoln's Inn.—The installation of the electric light at Lincoln's Inn is one of 220 lights, of which 96 are in the dining hall, 16 each in two retiring rooms, 16 in the vestibule, and 64 in the library. It is supplied with current by a dynamo driven direct by a Parsons motor, running at 9,000 revolutions per minute and situated in the basement, where two chambers measuring 18 feet by 7 feet 6 inches by 8 feet high, accommodate the boiler and the machinery, leaving ample space for access to all parts. The brackets and fittings have been designed to correspond with the internal decorations of the rooms, and the entire installation is working every evening with perfect regularity and success.

Electric Lighting in New Zealand.—Particulars are to hand of the lighting of Mosgiel woollen factory, near Dunedin, New Zealand, which has been carried out by Messrs. R. Fletcher and Co. The installation consists of 300 Swan-Edison lamps, of 20 C.P. each, driven from a "Victoria" dynamo of the Anglo-American Brush Corporation's manufacture. Some idea of the size of the installation, which is the largest in the colony, may be gained from the fact that nearly one mile and a half of main conductors and fully two miles of branch wires have been used for running the various circuits. The immunity from danger of fire is recognised as one of the greatest advantages of the electric light in woollen factories.

Electric Lighting at Denver.—Denver. Col., is to be lighted by electricity; incandescent lamps are to be placed on every lamp-post. An electric railway is nearly completed in the same city.

The Electric Lighting at Paddington.—Mr. E. de B. Barnett, writing from Westbourne Terrace, Hyde Park, to the *Times*, says:—"I was one of the applicants at the police-court some days ago, where I attended with my neighbours after finding that all private complaints to the company had no practical result. Since this action, the electric works have been temporarily stopped to allow of such alterations being carried out as, the company say, "it is believed" will remove all cause of complaint. It appears to me and my neighbours, however, impossible that anything short of the complete removal of the works can do away with the noise and vibration caused by what has been admitted to me, in the secretary's office, to be the largest installation of electric machinery in the world. I am also officially informed that it is intended to build a shaft in order to carry the steam and smoke above the adjacent houses. I have protested against this, and feel sure all the inhabitants of this valuable residential district will join with me in preventing such an unsightly (and doubtless ineffectual) erection in their midst. However, the matter is now before counsel, and every legal means will be used to protect this neighbourhood from an unjustifiable nuisance, which, had it been instituted by a private person instead of by a powerful company, could not have existed for a day."

Latest Developments of Electric Lighting.—Principal Jamieson, of the Glasgow College of Science and Arts, lectured on this subject last week before the members of the Greenock Philosophical Society. The lecture, which was of the popular order, was illustrated by diagrams and experiments, and was much appreciated.

The Electric Lighting at the Madras Club.—The experimental installation of the electric light at this Club at Madras has been extended as far as the power of the machine will admit, and embraces the most important rooms in the building. The current is generated by an Edison dynamo machine, driven at a speed of 1,200 revolutions a minute by one of Marshall & Co.'s engines hired from the Public Works Department for the experiment. There are three circuits conveying the current from the dynamo machine to the house. The largest of these circuits, which conveys the current to the reading room, bar, dining rooms, and passages is divided into a number of small sections, each consisting of 6, 9 or 12 lamps. Again, each lamp is fitted with a tap like a gas jet and may be lit or put out when required. Lamps of 16 candle and 10 candle-power are used, the latter being suitable for the passages, where much light is not wanted. The number of lamps now fixed in the Club is as follows :—

	16 candle-power.	10 candle-power.
Reading room	25	...
Large dining room	12	...
Small do.	4	...
Ante room	4	...
Bar	10	4
Strangers' room and passage...	9	2
Staircases and passages ...	6	2
Engine room	3	4
Card room	6	...
Small billiard room	6	...
Totals	85	12

The dynamo machine is constructed to work only 75 16 candle-power lamps; and although it can illuminate more than this number for a short time, it would be injurious to the machine to do so for more than a few minutes. The only serious objection to the lighting by electricity, as at present carried out at the Club, is the noise made by the engines, which is only too plainly heard in some of the rooms. But if the Club finally adopts the light, the engine will be placed rather further from the house. The installation was carried out by Mr. A. L. Paul, with the Edison Company's machine and lamps, and it is said to be the largest yet put up in India.

Electric Light at the Central Station, Glasgow.—The Glasgow Central Station of the Caledonian Railway was on Monday illuminated for the first time with the electric light. The installation, which is on the Brush system, consists of 40 lamps, of 2,000 candle-power each, for the platforms, &c., and two of double that strength for the yard. Fitted with carbons to last 16 hours each, the lights can be extinguished entirely or partially as required, and are provided with automatic regulators to absorb any surplus current. The wireage for the whole arrangement extends to about 5,000 yards, 3,000 of which are laid along the platforms, &c., and the other 2,000 in the yard. Two Brush No. 7 laminated machines are used, and the motive power is supplied by means of a horizontal steam engine of 70 horse-power, nominal, built and supplied by John Binnie, Star Engine Works, Glasgow. The globes, which are of alabasstrine glass, impart a pleasantly soft tone to the light, the effect of which was greatly admired. In the hotel, which forms part of the station, there are 180 Edison incandescent lamps, of 20 candle-power each. The whole of the electric appliances have been fitted up under the direction of Mr. S. Vyle, who joined the Caledonian telegraph staff early this year, to the entire satisfaction of Mr. Andrew Dunn, the telegraphic superintendent of the company.

The Reis Telephone.—A firm at Boston is manufacturing Reis telephones, and reports very satisfactory sales; indeed, it is found impossible to manufacture fast enough to meet the demand, and the premises are to be enlarged to increase the facilities.

A Telephonic Chess Match.—As already reported, telephonic communication has been established between Maryport and Workington by the National Telephone Company, and last week the chess players living in those two towns engaged in a match "by telephone." The new instruments at Mr. T. M'Graa's call office at Maryport worked excellently, and the players had no difficulty in making themselves heard at either end. Play commenced at half-past seven o'clock, and it was just four hours later on when Workington won three games and drew the fourth.

A Penny Telephone Service.—Mr. G. Sharples of Preston, has sent us particulars of a system which he has inaugurated in connection with the telephonic exchange in Preston of which he is the proprietor. By his arrangement any person can, upon payment of one-penny, call at certain stations and converse with any subscriber. The head office of the exchange is situated in the centre of the town, near most of the public buildings. A number of local firms have been supplied with instruments upon an undertaking to pay a penny for each time of using them, either for calling or when called, the record being kept, of course, in the switch room, and accounts sent every three months. Mr. Sharples states that the applications for instruments upon these terms are very numerous, but on account of their high cost he can only place them with such persons as are likely to use them a sufficient number of times to pay a reasonable percentage; when, however, patent rights have expired, or upon the introduction of cheaper instruments, he promises to make the system general throughout the town. The proprietor is enabled to offer so cheap a service by reason of the fact that he works the exchange in connection with his general business as an electrician, and has no special staff.

The Persian Gulf Cable.—It is announced that the new Telegraph Cable between Bushire and Jask, in the Persian Gulf, has been successfully laid. The steamship *International*, which left England with the second half of the cable a few days after her consort, the *Dacia*, met her at Jask on the 12th inst., when the operation of paying out was commenced, and the whole cable, 530 miles in length, was laid in perfect condition on the 20th inst.

A German-American Cable.—A certificate of incorporation of the German-American Telegraphic Cable Company has been filed at the State Capitol of New York. The corporators and trustees named, who are residents of Boston and New York, are as follows :—Henry Waterman, R. Philbrook, Benjamin F. Bradbury, George D. Rich, and Humphrey B. Wymans. The object of the company is to construct and operate a telegraphic cable from some suitable point at or near Boston to some point designated by the Emperor of Germany on the coast of that country; also a cable between Germany and Great Britain; also to lessen the expense in operating cables, as well as in receiving and transmitting messages from country to country, The capital stock is $12,000,000, which the company have the privilege of increasing to any sum sufficient to construct, land, and operate the cables. The stock is to consist of 480,000 shares of $25 each. The principal business office is to be situated in New York, with a branch office in Boston. The offices are to be opened as soon as the sum of $2,000,000 shall be secured from the sale of 5 per cent. coupon bonds issued by the company.

Telegraph Revenue.—The receipts on the telegraph service from April 1st to November 21st, 1885, were £1,145,000 against £1,150,000 received from April 1st to November 22nd, 1884.

The Indian Telegraph Department.—The Indian press is calling for an inquiry into the condition of the Government Telegraph Department, and the cause of the prevailing discontent among its officers. The remedial measures proposed by the Indian Government are said to be altogether inadequate, and it is hoped that an impartial committee will be appointed to hold an inquiry.

The Telegraph in Further India.—It is officially denied that any restrictions have been placed on the despatch of Press telegrams from Burmah. The meagreness of the news which reaches India is accounted for by the defective state of the telegraphic communications, owing to heavy rains and the rapidity of the British advance.

Another Paris Electrical Exhibition.—Encouraged by the success of the last electrical exhibition at the Paris Observatory, the International Society of Electricians is, we learn, preparing another for next spring.

Appointment.—*Nature* states that that well-known electrician, Dr. James Moser, who was working for some time at Prof. Guthrie's laboratory, has been appointed as *privatdocent* at Vienna University.

The Blackpool Electric Tramway.—The Blackpool electric tramway is now in full working order, according to the *Mechanical World*, and cars are running daily in both directions throughout the entire length, The corporation, at whose cost the tramway was laid, have issued a statement of the cost of the construction of the line, which, with the crossing places and the double portion on South Beach, is two miles 1,000 yards. From this it appears that the total sum expended has been £11,012. The cost of the electrical portion will not be known until the publication of the company's accounts.

A Narrow Escape.—The attendant of the dynamos at the Riverside Mill, Providence, recently received a shock from a forty-five light Brush arc machine, and was severely burned. He was adjusting the brushes, and it is supposed that the contact was made through his wet garments, as several holes were burned through his clothing. He was seen to fall among the wires, and was quickly removed, but not before several deep holes were burned in his flesh. He described his experience upon regaining consciousness as simply terrible from nervous suffering, accompanied with intense physical pain. He is rapidly recovering, and has resumed his work.

Generous Gift by Mr. Edison. — Mr. Edison has notified the authorities at Cornell University that he will present a complete electric lighting plant for the new workshops and the mechanical laboratory.

Scientific Society in Providence. — Some fifty members of the Providence (R.I.) Franklin Society, an old and well-endowed scientific society, have organised a sub-section, in order to more fully discuss electrical subjects.

Extension of Business. — Messrs. Woodhouse and Rawson inform us that they recently considerably extended their contract department, including electric lighting and electric signalling work of all kinds.

Professor Hughes and the Royal Society. — The Royal Society has, with the approval of the Queen, awarded its royal medal to Professor D. E. Hughes, on account of his scientific inventions and researches.

A New York Subway Company.—The New York Subway Company has been incorporated at Albany, with a capital of $5,000,000, for the purpose of establishing electric communication underground in the city of New York, by means of subways, cables, and conduits.

The Lighthouse Illuminant Experiments. — Mr. Wigham complains that an unfair advantage was given to the electric light in the recent experiments at the South Foreland, by its being used otherwise than as a proper lighthouse light. Mr. Wigham has written to the Board of Trade, asking that thorough investigation may be made into the subject of the best illuminant for lighthouses, and that the necessary steps may be taken to test the accuracy of his statements as to the report of the Trinity House, and the mode in which the experiments at the South Foreland, on which that report was based, were conducted.

Lumleian Lectures.—These lectures will be delivered at the Royal College of Physicians, in April, 1886, by Dr. Stone. The subject will be: "The Electrical Conditions of the Human Body: Man as a Conductor, Condenser, and Electrolyte."

Lloyd's.—Application is intended to be made by the corporation of Lloyd's in the ensuing session of Parliament for an Act to extend and enlarge their powers as regards the "collection, publication and diffusion of intelligence," and to provide that the publication and diffusion of any such intelligence shall be deemed to be a privileged communication from them. By other clauses power will be sought for to authorise them to establish signal stations and to erect signal houses, with all requisite telegraph and telephone wires, appurtenances, &c., "at such places on the coast of Great Britain and Ireland and the islands appertaining or belonging thereto as they shall think fit, and to maintain and work the same," such powers, however, together with the taking of lands or houses for the purpose, to be exercised only with the approval of the Board of Trade.

The New York Electrical Society.—At a recent meeting of this society the subject of the influence of magnetism on compasses and watches was discussed. The President, Dr. Van der Weyde, explained the cause of the disturbances and the various processes for demagnetising watches. The machine used for this purpose by Messrs. Giles Brothers, of Chicago, was exhibited and the method of its application shown. Mr. George W. Mansfield suggested a simple method of demagnetising a watch which he had tried and found to be quite effective. It consists in suspending the watch from a string, and twisting the latter, so that when released the watch is rapidly revolved. If, during its rapid revolution, the watch be gradually withdrawn from the poles of a dynamo, it will be found to have lost its magnetism. In regard to the disturbance of compass needles, Mr. Joseph Wetzler related the results of some experiments made with the view of determining the effects of local attraction caused by masses of iron. These were made in the streets of New York, and went to show that in the business portion of the city, especially in the vicinity of the elevated railroads and electric light stations, no reliance could be placed upon the readings of the needle. As an instance, it was shown that near the Edison central station the needle varied from 5 to 20 degrees from 9 a.m., when few machines were running, to 5 p.m., when all were at work. The president also made some remarks on the localising of faults in iron work by means of the compass needle, relating the results of an experiment which proved quite successful in determining a fault.

Erratum.—The word "simplification," in the third line of Mr. Fitz-Gerald's letter last week, was printed in error for "amplification."

Tests of Dynamos.—When shall we, in this country, be able to place on record a series of tests of dynamos carried out in such entirety as those just published of the Edison and Weston machines in Philadelphia? This might have been done during the run of the Inventions Exhibition, but probably something of the kind may be forthcoming next year.

Bichromate Batteries.—"W. N." in *Engineering*, gives the following description of a bichromate battery:—Six half-gallon stoneware jars (coffee cans) with holes for tap or plug. In each a round porous jar 9 in. by 3 in., surrounded by carbon plates and broken carbon. In the porous cell a zinc rod 8½ in. long, weighing 1½ lbs. Solution, common salt and water. The depolarising solution is for the six cells: water, 14 lb.; potash bichromate, 1¾ lb. at 6d. per lb., 10½d.; sulphuric acid, 6 lb. at 1½d. per lb., 9d.; total, 1s. 7½d. I have four 2½ candle-power 4·8 volt lamps in places where the light is only wanted for a few minutes at a time; one is used as a night light to be turned up when wanted. Besides this the current is used through resistances for bells, gas-lighters, &c. For this I use cells one to four in series, added to which a third wire is used with six in series in my work room either for 10 volt lamp, 5 candle-power, or other purposes. I am sure I under-estimate when I say the current is used 15 minutes a day. And for the second time this combination has lasted me over ten weeks. To equalise the wear of the solution I empty all the cells together about the fifth week, and refill with the mixed solution. The loss of zinc is about 2 lb. at 4d. per lb. = 8d., added to the cost of solution equals 2s. 3½d., or between ½d. and ¼d. per night. A night light alone costs ½d. The carbon of the cells I use has just been overhauled after six months continual use; there are hardly enough chrystals of chrome alum to cover a sixpence, but in each carbon cell is about 2 oz. of a pale bottle-green crystal, very brittle, and unlike chrome alum, easily detached from the carbons. I shall be much obliged if you can tell me what these are. I have never heard of the use of iron in the place of zinc in these batteries, and shall feel greatly obliged if any of your readers can give me any information on the subject. I have tried a short experiment with the following result:—Seven cells (pint round stoneware) in series. In each cell one iron plate immersed surface, 4 in. by 1½ in.; two carbon, immersed surface, 4 in. by 2 in.; in a solution divided among the seven cells of: water, 6 lb.; potash bichromate, 12 oz.; sulphuric acid, 41½ oz. This kept a 2½ candle-power (4·8 volt) lamp at a useful light for 3½ consecutive hours.

The Post Office and Pneumatic Tubes.—A Glasgow contemporary hears that an endeavour is being made in certain quarters to question the right of the Post-Office authorities to transmit by pneumatic tube messages that are entrusted to them by the public for transmission by telegraph, and are paid for according to telegraphic scale. It is urged that the cost of sending telegrams in bundles by pneumatic tube is considerably less than the cost of "wiring." It is rumoured that the dispute is likely to be tested by means of an action at law.

"A Swindle of the First Water."—A receiving order was made in April last in regard to the estate of Major Newson Dunnell Garrett, half-pay Royal Artillery, the petitioning creditor being the Gülcher Electric Light and Power Company, which has a claim of £989 10s. 5d. The public examination was conducted last week before Mr. Registrar Brougham, when the debtor alleged that the claim on which he was made a bankrupt was a fraudulent one. It was a "swindle of the first water." By a letter that he had from the chairman of the Gülcher Electric Light and Power Company, upon which he had based his claim of fraud, an agreement was drawn up that he was to surrender the whole of his shares in the Gülcher Company, which represented some £20,000. In that agreement the whole of the unpaid shares were not cancelled whilst they took them. They had practically acknowledged that they had taken them. He had sworn in his affidavit, in proceedings that had been taken in another branch of the law, that whilst they agreed to take 4,047 shares, they had only cancelled 3,547 shares, which left 500 shares in his own name. The examination was adjourned.

Abandoned Aërial Wires.—Every time a storm occurs in Philadelphia, according to an exchange, telegraphic and telephonic communication between different points in the city is greatly interrupted, and business men experience great inconvenience in transmitting despatches. "A great deal of this trouble," explained the chief of the electrical department, "is due to old, abandoned wires breaking down during the storms and falling on the others. Several years ago various telegraph and telephone companies strung their wires all over the city on housetops or anything else that they could fasten them to. Many of them were put up purely for speculation, and they are of poor quality and badly strung. Other companies lost their franchises in the courts and were compelled to abandon the use of their wires. The disused wires have become rotten and every time there is a storm many break and cross the working wires, causing great confusion. The trouble will continue until they are removed.

Vibration of Electric Machinery.—The proprietors of an hotel at 66, Cow Cross Street, Smithfield, last week appeared before Vice-Chancellor Bacon, to restrain the Consolidated Electric Light Company, of 66A, Cow Cross Street, from causing a nuisance by means of the noise and vibration of its electrical machinery. The steam engine was in the basement of the defendant's premises, the dynamos were on the ground floor, and a party wall separated the premises of the parties. The shaft of the engine was supported by girder bearings fixed into the party wall, and in this way was caused a noise and vibration which seriously inconvenienced the plaintiff's customers. Damages to the extent of £1,000 were claimed. The company denied plaintiff's statements, and alleged that the machinery had been working since May, 1883, no complaints being made till September, 1884. Upon examination, the tenant stated that his receipts had fallen £50 or £60 a month in consequence of the nuisance of which he complained. The case occupied a portion of two days in hearing, but was subsequently struck out of the list.

Dynamos and Engines.—On Tuesday evening last Mr. Gisbert Kapp read a most excellent paper before the Institution of Civil Engineers on "Continuous-current dynamo-electric machines and their engines." In due course we shall hope to place this before our readers. Detailed descriptions were given of nearly all the improved dynamo-machines now manufactured in England, including the Edison-Hopkinson, Mather and Platt, Paterson and Cooper, Elwell-Parker, Crompton, Greenwood and Batley, the Brush Company's, the Gülcher Company's, and the Author's dynamos. A table was also given which contained some of the more important constructive data of the various dynamos described, especially with regard to the density of current in armature and magnet-wires, and the cooling surface provided to dissipate the heat which was necessarily generated by the current passing through those wires.

Electrical Formulæ.—We should be pleased if our readers have any criticisms to make upon the series of papers just published by us from the pen of Mr. F. V. Andersen. The subject is a most important one, and, in this case, has special reference to the construction of dynamo machines.

The Telephone at Bournemouth.—The Bournemouth Improvement Commissioners recently referred to committee a communication from the South Wales and Western Counties Telephone Company, which proposes to carry overhead wires throughout the town.

Mr. Cyrus Field's Libel Case.—In the case of Cyrus Field *v.* Gordon Bennett, an application was made on Wednesday for fuller answers to interrogatories administered by the plaintiff; but the Court of Appeal dismissed the application, holding that the answers given were sufficient.

Electric Lighting in the City.—At a recent meeting of the Commissioners of Sewers, Mr. Altman in answer to Mr. Deputy Bedford, said the Streets Committee had had a large number of applications from different electric lighting companies, which were still under consideration. With regard to the offer that the Commission should take over the plant of a particular company, and carry the lighting out on their own account, the committee had seriously considered the matter, and were of opinion that if the Commission felt disposed to take up electric lighting on ther own account it would be better to buy new plant. The Commission was handicapped to a large extent by the present Act, and if it were possible to amend it their work might be very much easier. He hoped to bring up a satisfactory report at the next court.—Mr. Deputy Bedford was informed that the people who lighted Holborn Viaduct were prepared again to light the whole of it with double light for £500 a year. This was one of the most magnificent entrances into the City of London. —Mr. Altman said the offer of that company was still under consideration.

The West London Electric Lighting Order.—At a recent meeting of the St. James's (Westminster) Vestry, the Lighting Committee recommended, with reference to a letter from the West London Electric Lighting Company as to the delay in commencing operations under its order, that the company be informed that the Vestry regret that the company should now appear to raise any objection to proceeding with the carrying into effect the Electric Lighting Order obtained in 1884, until clause 27 of the Electric Lighting Act of 1882 has been altered, inasmuch as the company was fully acquainted with the provisions of the law before the order was granted, and that the Vestry hope the company will take steps for carrying the order into effect without any undue delay. The report was accepted.

Extension of the Telephone.—The Northern District Telephone Company is pushing on energetically between Sunderland and Hartlepool, and it is hoped that this will prove a most important and successful trunk line. Owing to the company's district containing such a large tract of country given up almost entirely to the coal mining industry, special efforts are being made to introduce the telephone as a means of communication in underground work. At present the only communication is, as a rule, by rappers or by electric bells ; and in ordinary working, but especially in cases of accident, such as explosions or flooding of the pits, the telephone will be invaluable. This company is contracting to supply a system of telephones at the works of the River Wear Commissioners Extension at Roker, where some very extensive and important piers are being erected, with a view to improving the entrance to the river.

The Telephone and the Cork Corporation.—At a recent meeting of the Cork Town Council, the Secretary of Committee reported that, in accordance with an order of the Council, the system of telephonic intercommunication had now been established between the various corporate offices. General satisfaction was expressed with this arrangement, and it was spoken of as the next best thing to a concentration of all the offices in one place.

Underground Wires in Milwaukee.—A delegation of Milwaukee aldermen recently visited Chicago for the purpose of inspecting the underground and overhead wire system there with special reference to electric lighting. Milwaukee is at present trying to decide what kind of an ordinance she will grant for electric lighting companies to operate under, and the result of the visit of the aldermen to Chicago will probably be shown in the further action which they take. The Milwaukee Council passed one electric light ordinance which seemed to be a very good one for both the city and the operating companies, but it was vetoed by the mayor.

Defrauding Workmen.—William Wilson, respecting whom we published a "warning" a fortnight ago, was on Wednesday committed for trial on a charge of obtaining sums of money from young men on the pretence of obtaining situations for them in an electric light company.

NEW COMPANY REGISTERED.

Ingrey, Poore and Latham, Limited. — Capital £4,000, in £10 shares, with power to increase. Objects: —To take over the business of electric engineers, merchants and agents, and of electric light apparatus contractors, carried on by Messrs. Charles Ingrey and Graydon Poore, at 49, Queen Victoria Street, E.C. Signatories :—Charles Ingrey, 49, Queen Victoria Street, 125 shares ; Graydon Poore, 49, Queen Victoria Street, 125 shares ; Ernest Latham, 10, Halton Buildings, Chapel Street, Liverpool, 50 shares ; Walter Mickelwright, 11, Queen Victoria Street ; Alfred Coatsworth, 11, Queen Victoria Street ; Hy. Johnson, 4, Peckham Grove, Camberwell ; John Buckett, 111, Norwood Road, Herne Hill ; 1 share each. Registered 20th inst., without articles of association, by Mr. J. Andrews, 32, Essex Street, Strand.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

London and Provincial Electric Lighting and Power Generating Company, Limited. — An order of the Chancery Division of the High Court of Justice, dated 29th ult., and filed on the 23rd inst., directs the striking off from the list of shareholders in this company, the name of Emanuel Gaminard, in respect of the shares No. 10,576 to 10,625 inclusive, with the liberty to the applicant to prove for the amount paid by him in respect of the said shares, together with interest thereon, at the rate of 4 per cent. per annum, in the winding up of the company.

Anglo-Spanish (Brush) Electric Light and Power Company, Limited.—The registered office of this company, formerly at 110, Cannon Street, is now situate at 22, Walbrook.

Fischer Electro Amalgamator Company, Limited.— The patents taken over by this company are as follows: —For England, dated 2nd April 1884 ; for Austro Hungary, dated March, 1885 ; for France, dated March, 1885 ; for the United States of America, dated June, 1885 ; for Victoria, dated April, 1885. Patents have also been applied for in Queensland, New South Wales, and New Zealand.

CITY NOTES, REPORTS, MEETINGS, &c.

The Pilsen-Joel and General Electric Light Company, Limited.

THE fourth ordinary general meeting of this company was held at the Cannon Street Hotel, on Thursday, the 19th inst., when Sir Rawson W. Rawson, chairman of the company, presided. The report of the directors, presented to the meeting, was given in the REVIEW for November 7th.

Mr. W. H. Trentham, secretary, having read the notice convening the meeting,

The Chairman said the report was a short one and to the point. It laid before them frankly and fully the position of the company. The directors had succeeded in carrying out the policy which was approved of at the last two meetings; they had got rid of the obligations connected with the factory and the office; they had reduced the expenses of management to a minimum; they had put the company into the way of working at a profit; and they had held in view the most important point, which was not to be under the necessity of making any further call on the share-

holders. They had now invested on behalf of the company £3,000, besides the balance in hand and at the bankers. They were working at a profit, and had reason to hope that the difficulties with regard to the arc lamp were overcome. Their patent was for an arc lamp which was not available for lighting houses or small areas, but was specially applicable to large areas, towns, or streets, large spaces and factories, and so forth. The time was now at hand when the public and the legislature were equally aware of the necessity of removing the restrictions which had hitherto lain in their way and prevented their development, and they had every indication, from the tenders they had been called to make, by the enquiries being made of them, by the general acceptation of the Pilsen arc lamp as practically the best now before the public, and from the fact that their patent was one which could not be superseded—it might be improved upon by themselves, but it could not be superseded by others—that they had succeeded in avoiding what many wished, which was the winding up of the company and the distribution of the assets, such as they were. They had succeeded in avoiding that rock and in placing the company on a footing which, he trusted, would enable them, on their present economical scale, to give something in return for the capital which had been invested in it. He then moved the adoption of the report and accounts.

Mr. Fyfe asked who made the valuation of the company's property last year, and who this. There was a great difference in the two values.

The Chairman said Mr. Dunstan, who was then the manager, made the valuation last year, and it was founded upon the usual principle of the valuation of the year before with a reasonable diminution for depreciation. But upon that point he might say that looking to what was expended by themselves and by all other electrical companies in the manufacture of their goods two or three years ago and looking to what the public now were willing to pay for them, and adding to that the necessity of a forced sale in order to get out of their factory and to reduce their annual expenditure, there was quite sufficient to explain the large depreciation noticed by Mr. Fyfe.

Mr. Hatton: Has the same principle been applied to the valuation this year?

The Chairman: No, certainly not.

Mr. Hatton: And has the same gentleman valued the stock?

The Chairman: No; but our present officers, under the advice and assistance of the auctioneer, who was a man exceedingly skilled in the value of machinery, and such stock as we possess is valued at what he expects he could get at a sale. Before, it was on what it stood at in our books; now, it is on what we might hope for if we were obliged to sell it to-morrow, and I think that is the best principle to act upon. One can understand why it was not adopted in the beginning; in fact, we could not value then, but could only estimate so much for annual depreciation. Now we have attempted to lay before you our exact position, what you actually have in possession, and the money and the stock and the plant upon which we hope to make a future annual profit.

Mr. Fyfe: Would you tell me the value in the books of Lewis's installation?

The Chairman: As far as my memory goes, it was £6,000, and I think it is reduced to about one-fourth.

Mr. Fyfe: That is not a fair valuation.

The Chairman: Then so much the better for the shareholders.

Mr. Fyfe: Oh, no, no; if you act upon that valuation in selling it, it will be wrong to the shareholders.

The Chairman: We shall sell it for as much as we can get.

Mr. Fyfe: No, you do not. Is it fair to value a plant which has an income of £369 a-year at £169?

Major Scriven (a director): I should say you ought to value stock at what it will fetch in the market.

The Chairman: I think the answer to Mr. Fyfe will be that Mr. Lewis has threatened to throw that stock upon our hands, and if we were forced to sell it we should not get more for it than the figure at which it stands. We value at what we might get.

Mr. Fyfe: No. You value those lamps at 10s. each, everything included, and you charge £2 royalty upon them. Surely the lamp is worth the royalty!

A Shareholder thought it was wise on the part of the directors to put the stock at lower than its value.

Mr. Fyfe: True, if they do not sell at that price.

The Chairman: Another great advantage is, that it will facilitate our making a dividend.

Mr. Fyfe thought not.

The Chairman: Yes it will; we can make no dividend until we wipe off our loss.

Mr. Fyfe: Exactly; but you are creating a great loss before you wipe off.

The Chairman: Does it signify whether you receive a very small percentage upon a large amount, or a large amount upon a small valuation?

Mr. King: What we want to know is, what we are worth as a going concern, and not as a dead horse.

Mr. Fyfe: Take the Bethnal Green Museum installation. That is valued this year at some £569. The annual profit at present, not taking into account the extra profit there will be this year, will be over £500. Is that a fair valuation?

A Shareholder: Absurd! Perfectly ridiculous!

Mr. Fyfe: It is earning the money; and we have the option, if it continues good, of selling the plant for £2,500. I do not think it is right to persons holding shares to depreciate the property in their eyes. They may be tempted to throw it away, whilst the time may come when they may be able to sell it at a profit, say of £1,000. Besides, if we depreciate our stock so much in the eyes of the public they will think the arc lamps are of no value.

Major Scriven said Mr. Fyfe was mixing up goodwill with value of stock. They could only value the stock at what it would fetch. They must not lose sight of the fact that the patents were down at the price which they cost the company. The goodwill had to pay for them. They had not undervalued the stock intentionally; they had not tried to make it of less value than it would fetch. They had studiously avoided anything like a fancy price based upon what it was bringing in. It might not fetch that to-morrow if a better lamp came in.

Mr. Fyfe remarked that the difference in the valuation was 78 per cent.

The Chairman stated that an error in the printing of the accounts had been pointed out to him. The capital account as reduced was put there at 28,000 shares of £4 each, £2 5s. paid. It should have been £3 each; £1 had been written off as loss, and £1 was reduced, so that the shares were £3 each, on which £2 5s. had been paid.

Mr. Fyfe: You stated last year the valuation was taken the same as the previous valuation, with a certain depreciation. That is not so, because I have here details of every article valued. In that you will find there are 4,000 Joel carbons, which, I understand, were sold to Mr. Joel. Everything belonging to the Joel lamps was sold for £25. The carbons cost £64. Anybody dealing in old metal would have given them double the money.

Mr. Joel said the lamps were offered to him. He was told there had been an offer of £20 for them, and he was asked if he could better that. He said certainly he could, and gave the company £5 more for them; he had them now.

The Chairman: We have not sold one Joel lamp. What is the use of keeping Joel lamps?

Mr. Joel said his lamps were never pushed; they never tried to sell them.

Major Scriven: Well, you were the manager for some time, Mr. Joel.

Mr. Joel: There was a market for the lamps, and I am selling them now at a good profit.

The Chairman said he was afraid there were a great many matters which might be open to remark, but they had done their best. They certainly had not been anxious to waste the property of the company. They had had a toilsome year in trying to do their best for the company, and if any gentlemen thought they might have done better, he only wished they had been in their places. Unless they saw any profit in further discussing the past, he would move the first resolution, that the report of the directors be received and adopted.

Mr. Tritton remarked upon the large sum of money in the balance sheet under the heading arrears of calls, £4,003, and asked how many shares it represented, and what steps had been taken to enforce payment.

The Chairman replied that the number of shares upon which the calls were unpaid was 4,852. Some of them were certainly a dead loss; there would be no difficulty in forfeiting them whatever. Others were held by two or three gentlemen who had been greatly interested in the company, and they hoped by giving a value to the business by holding out, as they fairly might, an expectation of its being a profitable concern, that those gentlemen would be able to pay their arrears and avoid the painful necessity of sacrificing the whole of their property.

Mr. Balfour asked how long the question would remain open. He supposed they would not accept those arrears without 10 per cent. interest.

The Chairman said that all those they believed able to pay they had made to pay.

Major Scriven said there was no immediate question of a dividend, and until there was he would ask them to be lenient to those who could not afford to pay up their calls.

Mr. Ellis asked if they were going to charge a rate of interest on the money owing by the defaulting shareholders when they paid up.

Major Scriven: Personally, I think we ought.

Mr. Fyfe said he happened to be in arrear to the extent of £332, and he was led into that position because the shareholders were not able to pay what they promised to the Union Company. He was a holder of 24,000 of the shares, and made a sacrifice of 76 per cent., and by doing that he was now unable to pay. He asked, would it be fair to make him pay 10 per cent. on that £332?

Mr. Ellis said he was not thinking of Mr. Fyfe when he spoke. He was perfectly certain the shareholders and the directors would be willing to take each case upon its merits. Mr. Fyfe's services to the company, he believed, had been very great.

Major Scriven: I can assure you we have not lost sight of the case.

The Chairman: I hope that what Mr. Fyfe has said will ensure for some of the defaulting shareholders the sympathy which the directors have felt bound to give them. It is not in the interests of the company, and it will be very hard upon two or three of them to enforce the strictest rule of their legal rights.

Mr. Ellis seconded the adoption of the report, which was carried with but one dissentient.

Mr. Tritton moved the re-election of Sir Rawson Rawson, the retiring director, which was seconded and agreed to.

The auditors, Messrs. Brown, Hays and Akers were then reappointed.

Mr. Tritton moved that the remuneration of the directors be £100 a year each.

Mr. Parrish seconded.

Mr. Roscoe moved as an amendment that the remuneration be £2 2s. each director for each meeting.

Mr. Joel seconded the amendment, but it having been pointed out that under such an arrangement the total remuneration would be much more than under the first proposition, it was withdrawn, and the original motion was carried.

Mr. Balfour moved that the shares on which the calls had not been paid up, be cancelled.

No one seconded this motion, and the Chairman stated that it could not be legally put in any case. It was afterwards amended to read as a direction to take the necessary steps for the forfeiture of the shares, but still not finding a seconder, it was withdrawn, and the proceedings terminated.

Blackpool Electric Tramway Company, Limited.—The report of the directors of this company, to be presented to the shareholders at the first annual general meeting, on Saturday, the 28th inst., states that the revenue account shows a profit of £63 10s. 6d., after meeting all working expenses, and the directors regard this result as very favourable, considering the many difficulties with which they have had to contend. The electric cars are now running, and the directors have every reason to expect a successful season next year.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the weeks ending November 13th and 20th were £2,359 and £1,885, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the two weeks ending November 13th and 20th were £3,063 and £2,635 respectively.

NEW PATENTS—1885.

14129. "Microphones for use in telephonic instruments." J. S. SELLON. Dated November 18.

14140. "Electrical generating apparatus and circuits for electrical installations and means of operating same." O. E. WOODHOUSE, F. L. RAWSON. Dated November 18.

14148. "Combined electric bell and pendulum indicator." A. F. LLOYD. Dated November 18. (*Complete.*)

14156. "Generating and inducing electric currents for actuating relays, block signalling, and interlocking apparatus on railways and tramways." J. RADCLIFFE. Dated November 19.

14169. "Electro-magnets." A. M. THOMPSON. Dated November 19.

14174. "Electric light switch." A. P. LUNDBERG. Dated November 19.

14212. "Magnetometer." A. MILLAR. Dated November 20.

14213. "Insulated electric conductors." A. MILLAR. Dated November 20.

14214. "Insulated electric conductors." A. MILLAR. Dated November 20.

14216. "Lighting railway carriages and tram cars by electricity." C. SMITH. Dated November 20.

14282. "Metal posts for carrying telegraph wires." E. EDWARDS. (Communicated by J. Gesquière.) Dated November 21.

14288. "Dynamo-electric machines." J. A. BERLY. (Communicated by Z. T. Gramme.) Dated November 21. (*Complete.*)

14297. "Galvanic batteries." C. REISS, F. HECHT. Dated November 21.

14300 "Electric lamps." C. REISS, F HECHT. Dated November 21.

14326. "Means or apparatus for regulating the action of dynamo-electric machines and motors." W. T. GOOLDEN, A. P. TROTTER. Dated November 23.

14354 "Electric lighting railway trains." A. M. CLARK. (Communicated by Electrotechnische Fabrik Canstatt.) Dated November 23.

14355. "Carbons for electric lighting." T. V. HUGHES, C. R. CHAMBERS. Dated November 23.

14381. "Electrical batteries." J. T. ARMSTRONG. Dated November 24.

14382. "Materials used in electrical batteries as substitutes for the ordinary exciting liquids." J. T. ARMSTRONG. Dated November 24.

14383. "Certain elements for electrical batteries. J. T. ARMSTRONG. Dated November 24.

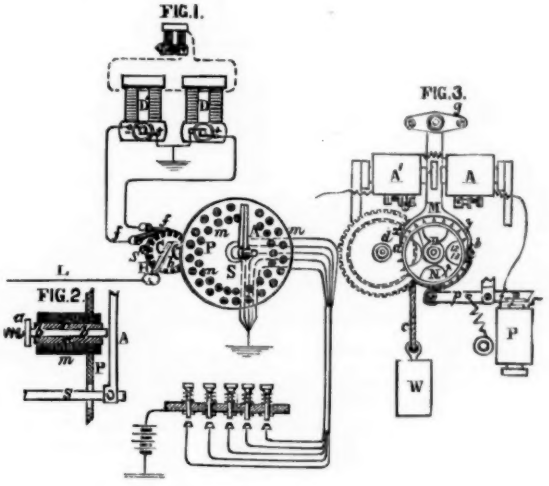
14384. "Porous plates for electrical batteries." J. T. ARMSTRONG. Dated November 24.

14383 (?). "Dynamo machines." M. IMMISCH. Dated November 24.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

12792. "Improvements in electric lamps." C. A. ALLISON. (Communicated from abroad by C. A. von Welsbach, of Vienna.) Dated September 25. 8d. Consists in causing two poles, between which a current passes, to rub briskly against each other under slight friction.

12953. "Improvements in printing telegraphs." W. H. DAVIES. (Communicated from abroad by G. B. Scott, of New York.) Dated September 29. 6d. Fig. 1 is a general view of the transmitter and its connections with the generators. Fig. 2 is a detail sectional view of one of the electro-magnets, all of which are alike used for stopping rotation of the shaft, and the circuit wheel for directing reverse pulsations to line. In these figs., *s*, is a shaft, to which is frictionally geared a motor of any suitable construction (not shown), firmly fixed to this shaft is the circuit-wheel, c, the periphery of which is divided into conducting and insulating spaces, the former being slightly shorter than the latter. They should be equal in number, equidistant, and together equal in number to the number of characters upon the type-wheel. The conducting portion of wheel, c, is electrically connected to a hub or roller, *h*, upon which bears an arm, H, to which the line wire is connected. Two spring fingers, *f*, f^1, rest upon the periphery of the wheel with sufficient force to form a good electrical connection therewith. These fingers are circumferentially distant from each other at contact, and upon the periphery of wheel c a space about equal to the length of one of the insulating sections on the periphery of c. Finger *f* serves to connect generator of electricity, D, of one polarity to line, and f^1 similarly serves to connect generator, D^1, of opposite polarity to line. As the circuit wheel, c, revolves in connection with the line



fingers, *f* and f^1, each alternately rests upon a conducting space and an insulating space, and *vice versa*. Thus a continuous series of reversals are directed to line. Firmly fixed to shaft, *s*, is an arm, A. P is a standard or fixture located in a plane parallel to but slightly distant (say a fraction of an inch) from the plane of rotation of arm, A. A series of electro-magnets, *m*, are located in this support, and are in number equal to the number of characters upon the type wheel. They are equidistant, and are placed in the circumference of a circle of which the arm, A, forms the radius. These magnets have a hollow core, *c*, through which passes a bar of brass or other non-magnetic material, *b*, fig. 2, to which the armature, *a*, is securely fixed. The free end of bar, *b*, normally rests, but slightly removed from the plane of rotation of arm, A. When the armature, *a*, is attracted, bar *b* is given a longitudinal movement, carrying it into the path of arm, A, by which means arm A, shaft *s*, and wheel c are arrested, and a conducting section of wheel c will rest under either *f* or f^1, by which means the last reversal directed to line is continued or prolonged. Each magnet is connected with a circuit closer or key by an independent wire connecting with a common battery, and by this means the series of key circuit closers may be located at any desired distance from the main line pulsater or transmitter. When the instruments are not in operation, arm A is at a zero position, as are also the type wheels of the receiving instruments. By depressing any particular key after arm A has been released, a series of current reversals will be sent to line before the arresting of A, sufficient in number to bring that character of the type wheel opposite the press pad, which corresponds with the character represented by the depressed key. Fig. 3 of the drawings illustrates the construction of the receiver. In this fig. N is an escapement wheel having recoil teeth, 1, 2, 12, 13. T is a type wheel, which is rigidly connected with escapement wheel, N, upon shaft, D, to which a constant tendency to rotation is imparted by the weight W, cord C, and an interposed gear train. M is an escapement yoke pivotted at *g*, having pallets, *x*, *y*, and adjustable set screws, *e*, *f*,

for limiting its to and fro movement. A, A^1, are escapement electro-magnets for controlling the vibration of escapement yoke, M. P is a press magnet controlling an armature lever, *p*, *p*, to which is attached a platen for impressing a strip of paper upon the characters upon the periphery of the type wheel. Pallett *x* is provided with two inclined surfaces, *a*, *d*, and pallett *y* with corresponding inclined surfaces, *b*, *c*. In the normal rotation of the escapement wheel, if the escapement yoke has moved to its extreme left position, the point of tooth 2 would have passed by the point of pallet, *x*, and thereupon the point of tooth 12, through the agency of the motor, impelled by weight w, would be immediately thrown against the inclined surface, *c*, of pallet, *y*. The impinging of tooth 12 upon surface, *c*, would conspire with electro-magnets A, A^1, to immediately move the escapement yoke from its extreme left position toward the right, and the escapement wheel would continue to rotate until the point of tooth 12 had passed the point of pallet, *y*. Upon the point of 12 passing the point of pallet, *y*, the escapement wheel again has a second free movement of rotation under the action of the clock motor until the point of tooth 1 comes in contact with the inclined surface, *d*, of pallet, *x*. However, if after the escapement yoke has reached its extreme left position, the rotation of the escapement wheel under the influence of the motor be arrested by a failure to withdraw the paper from the periphery of the type wheel, the reverse movement of the escapement yoke toward the right will bring the inclined surface, *a*, of pallet, *x*, against the point of tooth 2, and will thereby positively drive the escapement wheel, N, until the point of tooth 12 is just past the point of pallet, *y*. If the type wheel again fail to rotate under the action of the motor, the reverse movement of the escapement pallets to the left will bring the inclined surface of *d* to bear upon the point of tooth 12, and the escapement wheel will be positively driven another step, and so on. The type wheel is held during an impression by a prolonged impulse of either polarity.

13543. "Improvements in checking machines for public telephones." J. J. MANN. Dated October 14. 6d. Consists of a clock fixed in the face of a box containing upper and lower compartments. The upper compartment contains the connections to battery, line wire and transmitter and mechanism in connection with the clock, for regulating the time during which the connections are made for speaking to the central station. The lower compartment is a receptacle for metal tokens which after being purchased from the attendant or from the central office are used one at a time for bringing the transmitter into action. Any person desiring to speak through the telephone places one of these tokens on a small tray which stands in front of the box, under the clock; he then moves a handle which passes the token into the box, where by its weight acting on a lever the necessary connections are made, and the transmitter put in connection with the central station. After the lapse of a definite number of minutes the clock releases a catch and allows the token to fall into the lower compartment, from which it can only be recovered by means of a key which fits the lock of the said compartment.

15025. "Improvements in contact makers for the holders of incandescent electric lamps and for analogous purposes." A. SWAN. Dated November 14. 6d. The inventor provides spring attachments, which are screwed or fixed to split screws or forked attachments or the like, on the one part of the holder or the like, and give a spring bearing upon the wires or contact pieces of the other part of the holder or the like.

15030. "Improvements in electric arc lamps." F. THORNTON and O. ROMANZE. Dated November 14. 6d. For controlling the descent of the upper carbon the inventors form a screw rack upon the stem of its holder, and cause a worm to gear with this rack. The worm they carry by a slide, which can slide endwise of the stem, and which they suspend from the core or armature of a solenoid. The worm is of a quick threaded pitch, so that the weight of the carbon holder and stem, when resting upon the threads of the worm, may be sufficient to cause it to revolve. To prevent too rapid rotation of the worm they prolong its axis upwards, and mount a wheel on its upper end, which wheel is obstructed from revolving rapidly—it might be by arms upon it working in a thick liquid, or it might have escapement teeth around its periphery into which the pallets of an escape lever are made to engage, so that the rotation of the wheel is controlled by the rate at which this lever can vibrate—or any other suitable means for preventing too rapid a rotation of the wheel might be adopted. When a current is switched on to the lamp the arc is struck by the lifting of the solenoid core, as in the lamp described in the specification of a former patent, No. 3,901, granted in the present year—and the wheel at the upper end of the axis of the worm is thereby either brought against a fixed point or a point carried by the escape lever, and so the rotation of the wheel and consequent descent of the upper carbon is prevented—but as the upper carbon burns away, and less current passes through the coils of the solenoid, the solenoid core is drawn downwards by the weight of the carbon holder, and the wheel is free to revolve and the carbon to descend, until the current passing through the coils of the solenoid is again sufficient to lift the carbon holder, and so stop the wheel from turning.

15233. "Improved apparatus for effecting the transmission of electric energy to torpedoes, mines, or other objects capable of moving or of being moved." L. GOLDBERG and A. L. FYFE. Dated November 19. 6d. Relates to improvements in patent No. 3846, of 1883. The inventors propose to use similar means to those set forth in their former patent, but as it is obvious that on the firing or directing of the torpedo a projectile from the tube would cause a too sudden pull upon the cable or cables, they, in some cases to obviate this difficulty, arrange that the movement of the torpedo should rotate the drum, and they interpose a barrel, or other conveniently shaped spring, between the axis and the drum, whereby the jerk and sudden strain is taken and cushioned by the spring, so, as the pressure increases, to gradually communicate the same to the drum. In this case, a short length would be freed in the first instance, to allow of the distance that would be taken up by the spring before running at a surface speed equal to that of the projectile.

15273. "Improvements in incandescence electric lamps." F. WYNNE. Dated November 20. 4d. Relates principally to improvements in the deposit of carbon on the filaments and connections of incandescence electric lamps.

15331. "Improvements in electrical machines known as electrostatic inductive generators." C. L. CLARKE and H. J. COATES. Dated November 21. 6d. Instead of either brushes or springs, which have hitherto been in use in machines, particularly of the self-charging type known as the "Varley," the "Voss," and the "Wimshurst," the inventors employ centrifugal contact pieces pivoted on, or otherwise attached to the revolving part or parts of the machine, and placed in electrical contact either with the so-called "carriers," or with the collecting and distributing system, according to which part of the machine is arranged to revolve. The attachment is made in such a manner that the contact pieces will be extended or flung out by the centrifugal force, which is developed by the revolution.

15351. "An improved apparatus for destroying induction in electric wires." J. HART-DAVIES. (Communicated from abroad by K. Dembinski, of Belgium.) Dated November 21. 6d. Consists in using an apparatus consisting of induction bobbins made up of a wire of one millimetre in diameter covered over and completely insulated by and from an induction wire of one twelfth of a millimetre in diameter having a resistance of five hundred ohms. One of these bobbins so made is used for every pair of wires one of each pair being a telegraph wire the other a telephone wire which are attached to the terminals on opposite ends of the bobbin and the currents can pass through the induction wire and issue through the other terminal on the same ends of the bobbin at which they entered. Thus for a system of six wires three being telegraph and three telephone wires three of these bobbins would be used and so on and this anti-induction apparatus would be fitted up at the two extremities of a line while to each apparatus is supplied one similar supplementary bobbin to which two earth wires are attached one being for the telegraph wires on one end of this bobbin the other for the telephone wires on the other end of this bobbin. Between those two terminals on the end of each bobbin by which the telephone wires are connected to the said bobbin is fitted a commutator which connects the said terminals.

15357. "Improvements in means of suppressing induction in telegraph and telephone lines." J. C. MEWBURN. (Communicated from abroad by Marcel Deprez and Cornelius Herz, both of Paris.) Dated November 21. 6d. Relates to the use of compensating induction coils.

15439. "Improvements in apparatus applicable to telephony and telegraphy." J. STEPHEN. Dated November 24. 6d. Relates to an individual call apparatus on the metronome principle.

15566. "Improvements in regulating apparatus for electric arc lamps." G. E. VAUGHAN. (Communicated from abroad by The Austrian Small Arms Manufacturing Company, of Austria.) Dated November 26. 8d. One or both of the carbons, between the points of which the light arc is formed, is or are guided and held between guide rollers. The approaching movement, or the successive push, necessary for keeping the light arc constant, is effected by a shunt mechanism, which is put in action by an electro-magnet or solenoid disposed for automatic "current weakening" or "demagnetisation," and placed in the shunt circuit as soon as the light arc has reached a certain length, and the current circulating in the shunt circuit has increased to the required intensity. The leading object of this invention is to remove sensitive mechanical details such as are required where the approaching movement of the carbons is effected by gravitation or by a spring. The lamp is provided with an automatic shunt arrangement, by means of which a second path (besides that over the carbons) is supplied for the principal current, in case it is interrupted from any cause, but especially for lighting the lamp when the carbons do not touch. In this second path the current passes through a powerful electro-magnet and resistance coil inserted behind it, which re-establishes approximately the light arc. The carbon holder is set free on the magnet attracting the armature, so that it glides downwards without the action of the shunt arrangement, by means of its weight, until the upper carbon carried by it touches the lower one. Finally, an automatic safety apparatus is provided in this lamp, which prevents an abnormal length of the arc, in case, owing to some irregularity in the shunt mechanism, the latter should not push together the carbon points.

15579. "Improvements in the art of telephony." C. A. DAY. (Communicated from abroad by J. Lowth and W. D. Ewart, both of America.) Dated November 26. 4d. Consists in the use, in connection with a telephone, of a bar or rod, preferably of wood, which is arranged so that one end will be in contact with the proper part of the telephone while the other is adapted to be placed in contact with the throat of the speaker using the tele phone.

CORRESPONDENCE.

Secondary Generators or Transformers.

We had till yet viewed in a most objective manner the controversy raised by Messrs. Gaulard and Gibbs, and in our reply to their letter of the 17th September we behaved accordingly, as we had thought that by acting in this manner we will most easily succeed in convincing those gentlemen of the impossibility of maintaining their pretended claims. We sincerely regret that the said gentlemen render it impossible for us to pursue in that manner, as their last letter (published in your issue of the 7th inst.) does not contain any new facts, but is written in a merely subjective manner. The very few objective remarks in this letter refer particularly to the treatise of Prof. Ferraris, and it would not be proper for us to prejudice in any way the opinion of Prof. Ferraris. If, as yet, this gentleman did not deem it necessary to reply to the objections made by Messrs. Gaulard and Gibbs against his treatise, he no doubt will know very well why he is doing so.

As regards the calculation presented by Messrs. Gaulard and Gibbs, in order to prove that their 2 H.P. apparatus is capable of giving 4 H.P., we beg to remark that this method of calculating has by no means convinced us. Such an overworking of the Gaulard apparatus might be a fair thing as long as it is demonstrated by paper, but we cannot grow very "*échauffé*" by reading of such an idea. The much more might this be the case with the poor, vexed generator, and we doubt very much whether that generator will be capable to endure for any longer time such a large amount of "*échauffément*."

Messrs. Gaulard and Gibbs are kind enough to recognise our right for using alternating current machines and employing induction, even if those machines be hyper-compound, but they add the amiable instruction that this property does not seem to them to compensate for variations in speed.

We beg to thank those gentlemen for their kind instructions, but we would remark that there are already eight years that we are occupied with the study, construction, and the employing of alternating current machines, that consequently we are fully acquainted with the properties and effects of such machines, and therefore Messrs. Gaulard and Gibbs may leave to us all care concerning the methods how to make our system answering best to the requirements of electric lighting. We think we have already practically proved that we are not quite unable to fulfil such a task.

But the said gentlemen are not willing to allow us to "use without their authority transformers constructed in accordance with the rules they have been the first to lay down, which rules, as they say, alone enable the obtaining of the effective return, the bare possibility of which they have had so much trouble to get admitted." In reply to this, we will compose the fears of these gentlemen by assuring them in the most decisive manner that in our interest, as well as in the interest of electric lighting by transformers, we will most carefully abstain from observing, in the construction of our transformers, those rules which they claim so energetically to be their exclusive property.

The great difference between our transformers and the Gaulard generator consists especially in the fact that in our apparatus not only each spire, but also each single winding, is equally induced and efficient; this being not in the least the case with the apparatus of Messrs. Gaulard and Gibbs. We have reduced to a minimum the circulation of noxious Foucault currents, not only in the iron, but also in the copper itself, by making each single winding of equal E.M.F. Very essentially differing from the often cited rule of Messrs. Gaulard and Gibbs, in our transformers the relative position of the several primary and secondary windings is entirely indifferent.

Messrs. Gaulard and Gibbs pretend that this disposition has been most solemnly acknowledged to be their property by the International Jury of the Turin Exhibition, and they wonder how we can deny any resemblance to exist between our transformers and their generators. To this we might reply that the judgment of a jury of an exhibition may indeed confer much honour upon the respective exhibitor, without, however, constituting any right for claiming a priority with regard to some scientifical or technical idea. A jury of an exhibition has merely to declare what merits or advantages are embodied in the apparatus to be examined, without paying any regard to the judicial consequences that might eventually be deducted from that judgment.

Messrs. Gaulard and Gibbs repeatedly reproach us with having constructed our transformers by making use of those details of working and construction which they had communicated to us at Turin. In reply to this, we would ask those gentlemen what details they had communicated to us besides those which had been already made known to the International Jury, and consequently to the public? We would ask especially Mr. Gaulard, whom Messrs. Zipernowski and Blathy had had the honour of seeing at the Turin Exhibition, by what communications he thinks to have facilitated us the construction of our transformers, considering that up to the date of his first controversy against us, that is, up to the 17th September, 1885, he did not even understand the essential features of our annular transformers, which he had identified with a bipolar Fuller apparatus!

We have already begun towards the year 1883 to study the question of transforming electric currents and to make experiments to this effect. What we have learnt from Messrs. Gaulard and Gibbs at the Turin Exhibition, was the method how a transformer is *not* to be constructed, and the conversations we had had with Mr. Gaulard were confined almost exclusively to the statement of widely differing views with regard to the best form of transformers. We took that opportunity for telling directly to Mr. Gaulard that his arrangement of the discs, &c., does not seem to answer to the purposes aimed at, and we still hold that opinion, as in consequence of this arrangement there are generated Foucault currents in the copper-discs, which reduce sensibly, not the so-called electrical, but the *commercial* efficiency.

We may add, that as our patents have been filed in almost every European country, several patent offices have asked from us explanations with reference to presumed resemblances in our apparatus with very old induction-apparatus described in scientific works; but no patent office has made any reference to resemblances existing between our transformers and the Gaulard generators.

Messrs. Gaulard and Gibbs complain that all progress would be quickly stopped if it would be allowed to make improvements in the construction of already existing objects, and they refer to the great sacrifices in time and money they had had in working out their invention.

We sincerely regret that Messrs. Gaulard and Gibbs have had so considerable outlays which, as it seems, have not brought the awaited success; but we hope everybody will agree with us, if we say that, in contrary, every progress would be quickly stopped, if it would *not* be allowed to improve already known, but defective objects. Besides, as we have already pointed out in our reply to the first letter of Messrs. Gaulard and Gibbs, these gentlemen would have spared a good deal of the sacrifices they complain of, if they had read Maxwell's treatise, where in art. 679, the proportions of a cylindrical pair of coils of maximum mutual induction are given thus :—

Z diameter of iron core; Y and X, diameters of the two coils; $X : Y : Z = 4 : 3 : 2$; that is, the iron core must have half the diameter of the total coil, while the section available for windings is equally divided between the primary and secondary coils respectively.

In the apparatus of Messrs. Gaulard and Gibbs,

$$X = 110^{m}/_{m}, \quad Z = 52^{m}/_{m},$$

and the aggregate sections of the primary and secondary coils are equal.

We will not refer to our own sacrifices, and to the pains we had to take, but we would conclude by remarking that should Messrs. Gaulard and Gibbs proceed in the same rash and inconsiderate manner to the realising of their threats against the users of our apparatus, as they have behaved in their controversy against us, they might make experiences which will prove much more bitter than those they are already complaining of.

We have thought it our duty to publish these explanations, not only for the benefit of Messrs. Gaulard and Gibbs, but also in order to allay the fears of those of your readers who might have taken seriously the threats of Messrs. Gaulard and Gibbs.

Charles Zipernowski,
Max. Deri,
Otto T. Blathy.

Budapest, 20*th November*, 1885.

Mr. F. V. Andersen's Electrical Formulæ.

In last week's contribution of the very interesting series of articles by Mr. Andersen, I notice several formulæ which, though not without interest in their present condition, may be reduced to a simpler and more practical form.

Mr. Andersen says of his formula VI.:

"Suppose in one magneto machine $F_I = \cdot 5$, in another $F_{II} = 1$, and suppose these two machines are put to work under the same condition, *i.e.*, running at the same velocity, and giving out the same number of ampères per square inch of armature conductor; the latter will convert double the amount of energy, and waste half so many per cent. of what it converts as the former, while it is doing double the amount of work in equal space of time. It will, therefore, from an electrical point of view, considering that it contains the same amount of copper wire, be just to express its merits as twice that of the former machine."

But this, I think, can be better expressed by saying that:

"The comparative efficiency of magneto machines having armature conductors of equal masses, is proportional to the square of the electromotive force generated per unit of length of conductor, when the conductors have equal linear velocities."

Mr. Andersen has not mentioned the case of machines having different amounts of conductor on their armatures. This is an important case, since the difference in the amounts of conductor will produce a difference in the cost as well as in the electrical efficiency of the machines:

"The comparative electrical efficiency of magneto machines is proportional to the product of the mass of the conductor of the armature and the square of the electromotive force generated per unit of length of the conductor, when the conductors have equal linear velocities."

It will be observed that Mr. Andersen speaks of one machine having twice the efficiency of the other, because it performs work at twice the rate of the other, while it wastes only half as much per cent. of its work. But this is not in accordance with common usage. It is usual to compare the efficiency of the two machines, when they perform work at the same rate. And when this is done (in the example given) the one machine has four times, not twice, the efficiency of the other.

Mr. Andersen was probably led to his result by the condition of his formulæ IV. and VI. If in formula VI. he had expressed the current in terms of electromotive force and resistance, or had he expressed the electromotive force in terms of resistance and current, the formula would have been reduced to the form

$$1 - \frac{\text{internal resistance}}{\text{total resistance}}$$

which is the well known and simplest formulæ for electrical efficiency. This formula also, of course, expresses the efficiency of a direct circuit dynamo.

From his formula IV. Mr. Andersen infers that *the activity of a dynamo, i.e., its capacity for converting energy, is proportional to its* F. This is, of course, the case when a is constant; but if a is kept constant, the resistance of the circuit, R, must vary inversely as F; so that Mr. Andersen's formula does not express the whole of the circumstances of the case. To clearly express the relation between W and F, the effect produced should be considered when F alone varies; if therefore a is expressed in terms of F and R, the rate at which the machine will perform work will be proportional to F^2, and not to F.

W. Moon.

The Bell Patents in America.

Your quondam *verbose* correspondent takes leave to make a few comments upon statements made in your leader of October 31st, and he sends you the published reports of the proceedings now in progress before the Secretary of the Interior, who is the head of the department under which the Commissioner of Patents is placed.

In the first place, you are in error when you say that "the most effective antagonism to the Bell patents has resulted in a complete *fiasco*." You will be convinced, from a perusal of the papers sent herewith, that there is a law authorising a suit to be brought by the United States to vacate a patent, when fraud is alleged —I refer you to the case of the United States *v.* Warren —see enclosed slip No. 1.

You will learn from the enclosed slips from N.Y. newspapers, that the Secretary of the Interior is now engaged hearing parties opposed to Bell's patent—and also Bell's attorney—on the question of the validity of Bell's patent. Now, I have always held that Bell did not invent the telephone, but I wish to be just, and I will not sacrifice my opinion as an electrician for any filthy lucre.

In my opinion the only question which the Secretary of the Interior has to decide, is, whether Bell obtained his patent by *fraud*, and that the fraud consisted in having fraudulently obtained information from the patent office of the contents of the *caveat* filed by Gray, two hours after Bell filed his application, with full specification, for a patent.

I do not think that the Secretary of the Interior has any right to inquire in regard to any of the prior inventions to Bell's, because all those alleged prior inventions have been adjudicated upon by the U.S. Circuit Court, and no officer of the Government can review any judgment of a Circuit Court.

Now, as to the evidence of fraud on the part of Bell to obtain the contents of Gray's caveat, there is not a particle. It is clear that Bell did not use any of Gray's devices, as Bell's patent clearly shows.

In fact, the opponents of Bell argue: 1st. Bell's instrument in his first patent will not work. 2nd. Bell took his ideas of telephony from Gray's caveat. 3rd. Gray's instruments will work.

Now, I maintain that Bell could not have taken Gray's invention, because if he did Bell's instruments would work.

In my opinion these proceedings are got up by parties as a speculation. Let them, if required, take appeals to the Supreme Court of the United States, as the Molecular Telephone Company has done, and then the merits of the controversy will be judicially investigated and adjudged.

I am of the same opinion I have expressed in your REVIEW—that Bell did not invent the telephone—*which is his claim* in the United States; and I say to his opponents, let them prove it—as the Dutchman said: "True, I killed his dog, but let him prove it."

W. C. Barney.

Grand Central Hotel, New York,
November 14*th*, 1885.